

COOCH BEHAR PANCHANAN BARMA UNIVERSITY



REVISED SYLLABUS (Updated, 2019)

for MSc.

in

ZOOLOGY

Effective from August 2019 for all batches

[Revised syllabus, 2017 will only be followed for Back papers prior 2019]

Total Credit: 80

Credit per Semester: 20

Total Marks:1600 (for four Semesters)

Theoretical & Practical Papers: 1200 + Continuing Evaluation: 320 + Attendance: 80

FIRST SEMESTER

Course No.	Name of Course	Marks				Credit
		ESE	CE	A	Total	
T-101	Functional Biology of Nonchordates + Chordates	75	20 (Class Test)	5	100	5
T-102	Biochemistry +Environmental Physiology	75	20 (Seminar)	5	100	5
T-103	Ecology +Animal Behaviour	75	20 (Class Test)	5	100	5
P-104	Practical: Chordate & Nonchordate (A) + Biochemistry & Environmental Physiology (B)+ Ecology &Animal Behaviour (C)	25(A) + 25 (B)+ 25 (C) = 75	20 (Comprehensive Viva Voce)	5	100	5

SECOND SEMESTER

Course No.	Name of Course	Marks				Credit
		ESE	CE	A	Total	
T-201	Immunology + Biotechnology	75	20 (Class Test)	5	100	5
T-202	Insect Biology + Aquaculture and Fisheries Resources of India	75	20 (Class Test)	5	100	5
T-203	Cell Biology + Genetics	75	20 (Class test)	5	100	5
P-204	Practical: Immunology & Biotechnology (A) + Cell Biology & Genetics (B)	40 (A) + 35 (B) = 75	20 (Field study on Entomology/ Fisheries- Group work)	5	100	5

THIRD SEMESTER

Course No.	Name of Course	Marks					Credit
		ESE	CE	A	Total		
T-301	Taxonomy & Biosystematics + Biodiversity & Wildlife	75	20 (Field Study)	5	100	5	
T-302	Developmental Biology & Gamete Biology + Endocrinology	75	20 (Class Test)	5	100	5	
T-303 (A-G) Theory	Cellular and Molecular Immunology/ Molecular Cell Biology & Genetics/ Parasitology and Epidemiology with Artificial Intelligence Application/ Ecology/ Entomology / Fisheries / Biodiversity & Wild Life Conservation	50	20 (Seminar on Review/ Dissertation)	5	100	5	
S-303 (A-G)	Manuscript Submission (Review/ dissertation/internship)	25					
P-304	Practical: Developmental Biology & Gamete Biology (A) + Endocrinology (B) Manuscript submission (C): Review/ Dissertation/ Internship on Special paper	40 (A) + 35 (B)= 75	20 (Comprehensive Viva Voce)	5	100	5	

FOURTH SEMESTER

Course No.	Name of Course	Marks					Credit
		ESE	CE	A	Total		
T-401	Biophysics & Biostatics +Neurobiology	75	20 (Class Test)	5	100	5	
T-402	Evolutionary Biology +Population Genetics	75	20 (Class Test)	5	100	5	
T-403 (A-G)	Cellular and Molecular Immunology/ Molecular Cell Biology & Genetics/ Parasitology and Epidemiology with Artificial Intelligence Application / Ecology/ Entomology / Fisheries / Biodiversity & Wild Life Conservation	50	20 (Institute Visit related to Special paper)	5	75	5	
P-404 (A-G)	Practical course of Special paper	50	20 (Comprehensive Viva Voce)	5	125	5	
S-404	Review/ Dissertation/ Institutional Internship (Manuscript submission & Seminar)	50					

Note: In case of Review/Dissertation, students will be assessed on the basis of their manuscript submission and seminar presentation.

FIRST SEMESTER

THEORY

Course No.T-101 (Group-A)

Full Marks:40

Functional Biology of Non-Chordates

1. Animal Architecture: Body Symmetry, Body Size and Body Cavities
2. Locomotion:
 - a) Hydrostatic movement in Cnidaria, Annelida and Echinodermata
 - b) Significance of Segmentation with reference to locomotion
3. Respiration:
 - a) Physical factors, respiratory pigments in Non-chordates
 - b) Mechanism of respiration by gills, book lungs and tracheae
4. Nutrition and Digestion: Feeding pattern in lower metazoans
5. Excretion:
 - a) Excretory products, structures and mechanisms of excretion in Nonchordates
 - b) Osmoregulation in Non-chordates
6. Nervous System:
 - a) Primitive and advanced type of Nervous System
 - b) Trend of neural evolution in Non-chordates
7. Evolutionary Significance of non-chordate larval forms

Course No. T-101 (Group-B)

Full Marks:35

Functional Biology of Chordates

1. Biological Design:
 - a) Basic Vertebrate body plan and characteristics
 - b) Mechanics of body support and design: Size, Shape, Optics and Strength
2. Integument:
 - a) Phylogeny: Integument of Fishes, Integument of Tetrapods
3. Jaw Suspension: Fundamental and evolutionary significance, Cranial kinesis, Intracranial mobility in feeding mechanisms
4. Temporal region of the Reptiles and evolutionary significance
5. Auditory system: Evolutionary changes and adaptive advantage
6. Evolution of cerebrum, functional association of CNS and information processing, role of cephalization in higher brain function
7. Sensory Organs: Chemoreceptors, Radiation Receptors, Mechanoreceptors and Electroreceptors

Course No. T-102 (Group-A)**Full Marks: 40****Biochemistry**

1. The nature of non-covalent interactions (van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction etc.)
2. Bioenergetics: Internal energy, First Law of thermodynamics, Enthalpy, Entropy, second law of thermodynamics
3. Conformation of proteins (Ramachandran plot, secondary structure, domains, motifs and folds)
4. Conformation of nucleic acids (A,B,Z), Reassociation kinetics and genome complexity, C-value paradox.
5. Stability of protein and nucleic acids
6. Lipids as signals cofactors and pigments.
7. Enzymes: Kinetics, regulation, mechanism of catalysis, isozymes.
8. Glycolysis and its regulation, Citric acid cycle and its regulation, oxidation of fatty acids, oxidative phosphorylation, electron-transfer reaction in mitochondria.

Course No. T-102 (Group –B)**Full Marks: 35****Environmental Physiology**

1. Stress Physiology: Basic concept of stress and strain, stress avoidance, stress tolerance, etc.
2. Basic concept and mechanism of Homeostasis
3. Respiration: Respiratory pigments: Oxygen dissociation curves: Transport of oxygen and carbondioxide: Bohr effect, Root effect & Haldane effect; Physiology of diving birds and mammals.
4. Circulation of body fluids-Patterns of circulatory systems in animals: Kinds of blood vessels, Conductive tissue systems of heart in mammals: Cardiac cycle: Concepts of Electro Cardio Gram (ECG): Blood pressure: Concepts of haemodynamics.
5. Excretion and Osmoregulation:
 - a) Excretion-Concept of excretory organs in animals: Gross anatomy of kidney in mammals: Glomerular Filtration Rate: Tubular reabsorption and secretion.
 - b) Osmoregulation-Control of osmoregulation via ADH: Osmoregulation in aquatic and terrestrial animals.
6. Thermoregulation: Concepts of terminologies used (Endotherm, Ectotherm, Homeotherm, Poikilotherm, Heterotherm, etc); Concept of Temperature Coefficient (QIO); Adaptations to cold and heat by aquatic & terrestrial animals; Adaptive Hypothermia and Adaptive Hyperthermia; Thermal Neutral Zone; Thermogenesis, Evaporative cooling.

Course No. T- 103 (A)

Full Marks: 40

Ecology

1. Community Ecology: Community Ecology-Biotic community concept, ecological dominance, Community analysis, species diversity, Competition and Coexistence, intra-specific and inter-specific interactions, scramble and contest competition models, mutualism and commensalism, prey-predator interaction
2. Population Ecology: Characteristics of population, population size and exponential growth, limits of population growth, population dynamics, life history pattern, life table, fertility rate and age structure, dispersal, concept of metapopulation.
3. Human Ecology: Human population growth, resource use and sustainability
4. Environmental Stresses and their management, global climatic pattern, global warming, atmospheric ozone depletion, acid rain, coping with climatic changes.
5. Pesticides and other chemical in agriculture, industry and hygiene and trends of their use.
6. Factors influencing bioaccumulation in food chain and during trophic transfer. Impact of chemical pollutants on biodiversity of microbes, animals and plants.
7. Bioindicator and biomarkers of environmental health. Biodegradation and bioremediation of chemicals.

Course No.T-103 (Group - B)

Full Marks:35

Animal Behaviour

1. Ethology: Definition, Scope, Importance, Nature of questions to be asked, Basic concepts and models of classical ethology.
2. Innate and learning behavior: Definition, classical conditioning, Instrumental learning, habituation and imprinting
3. Survival value of behavior: Kin selection, Prisoner's dilemma, selfish gene theory and green beard hypothesis
4. Foraging: Optimal foraging theory; learning and foraging; molecular, neurobiological and hormonal aspects of honey bee foraging

5. Communication: Communication and honesty; Communication venues like aggression, predation, song, complex communication
6. Courtship and mating behavior in Scorpion flies, Guppy, Tiger
7. Nidification in birds [Common (Sparrow, Crow, Tailor, Woodpecker) and water (Pond heron, Stork, Waterhen, Kingfisher)] and brood parasitism
8. Wildlife behavior: Aggression, agonistic behavior, competition, territory, dominance, movements and conflict.
9. Abberant behavior in mammals and birds.

LABORATORY COURSES

Course No. P-104 (Group-A)

Full Marks:25

Practical: Non Chordate and Chordate

Non-Chordate :

1. Mounting of: *Paramecium*, *Nectotherus*, *Amoeba*, *Opalina*, Soil Nematodes, Gut nematode of fish and toad, Cyclops, Daphnia,
2. Preparation- Mouth parts and salivary glands of cockroach, Mouth parts of Mosquito
3. Submit a project report to study the diversity of Protista of pond water collected from different places
4. Identification of Larva: Ephyra, Nauplius, Zoea, Mysis, Megalopa, Glochidium, Trocophore, Veliger, Bipinnaria.

Chordate:

1. Location and extraction of pituitary gland of carp
2. Find position of accessory air-breathing organs of *Anabas* / *Clarias* / *Heteropneustes*
3. *Gallus/Columba*: 5th and 7th Cranial nerves
4. *Rattus/ Mice*: Nerves of the neck region

Course No. P-104 (Group-B)

Full Marks:25

Practical: Biochemistry & Environmental Physiology

1. Genomic DNA extraction
2. Quantitation of DNA by UV-spectrophotometer
3. Electrophoretic separation of DNA

4. Protein estimation by Folin Lowry method.
5. Comparison of Total RBC and WBC counts in different groups of vertebrates
6. Estimation of Haemoglobin and Differential count of blood in vertebrates
7. Study of the changes of blood glucose level in a vertebrate species

Course 104 (Group-C) Full Marks: 25

Practical: Ecology & Behaviour

1. Water Analysis: Estimation of dissolved oxygen, free carbon dioxide; total alkalinity; total hardness and chloride
2. Soil Analysis- Estimation of percentage of calcium carbonate by rapid titration method. Estimation of Organic-carbon by wet oxidation method
3. Estimation of primary productivity of aquatic ecosystems using light and dark bottle method.
4. Assessment of density, frequency and abundance of plants/animal in a community using various techniques i.e. transect, quadrat etc.
5. Study the aggressive behavior of Fish (*Channa / Betta*)

SECOND SEMESTER

THEORY

Course No.T- 201 (Group – A)

Full Marks:40

Immunology

1. History of Immunology: Early concepts, Germ Theory of Diseases (Louis Pasteur & Robert Koch), Emergence of Immunology as a concept (ElieMetchnikoff, Paul Ehrlich, Karl Landsteiner and others)
2. Organization of the Immune System: Ontogeny of the Immune System, Lymphoid Organs and Tissues
3. Components of Immunity:
 - a) Innate Immunity: Chemical and Physical Barriers, Phagocytosis, Inflammation, Complement system

- b) Adaptive Immunity: B lymphocytes (Antibody mediated), T lymphocytes (Cell mediated), Antigen Presenting Cells, NK Cells
4. Immunoglobulins: Structure, classes and functions
 5. Transplantation Immunology: Major Histocompatibility Complex (Types & functions)
 6. Cancer Immunology: Oncogenes & Tumor suppressor genes, angiogenesis & metastasis, virus induced cancer
 7. Hypersensitivity: Types and its related diseases
 8. Concept of Tolerance; mechanism of breakdown of tolerance leading to Autoimmunity.

Course No. T-201 (Group – B)

Full Marks: 35

Biotechnology

1. Recombinant DNA technology: Restriction Endonucleases, Vectors, Cloning strategies, selection of recombinant DNA, DNA sequencing, PCR, Next generation sequencing, Shotgun sequencing of whole genome, cDNA libraries: construction and screening. Plasmid mapping, Transposons
2. Expression vectors and expression of fusion proteins
3. Transgenic Animals: production, prospects, advantages and disadvantages
4. Site directed mutagenesis: strategies and prospects
5. Applications of recombinant DNA technology in human gene therapy, vaccine development, environmental bioremediation and protein engineering
6. Microbial synthesis of commercial products: restriction endonucleases, antibiotics, vitamins, amino acids and dyes

Course No. T-202 (Group – A)

Full Marks: 40

Insect Biology

1. Insect Classification- Major order with characters and examples
2. Trophic adaptations in insects
3. Reproductive strategies in insects
4. Insect development, metamorphosis and life cycle patterns
5. Concept of pest status and classification of pesticides
6. Introduction to major vectors, pest of medical and agricultural importance from India
7. Remote sensing techniques in assessing Crop damage and protection
8. Methods of insect pest control: Conventional and non-conventional
9. Concept of integrated pest management

Course No. T- 202 (Group – B)

Full Marks: 35

Aquaculture and Fisheries Resources in India

1. Aquaculture: Definition, scope and importance; Aquaplosion; Aquaranching
2. Concepts of different systems of freshwater aquaculture and their management
3. Basic cultural aspects of Ornamental fishes, Air-breathing fishes, Freshwater prawns and their prospects and problems.
4. Hypophysation technique, Synthetic Hormones (Ovaprim, WOVA-FH,etc.), Chemical structure, Role and Utility in induced breeding, Inbreeding Depression.
5. Hybridization in Fishes; Basic concepts of Selective Breeding in Fishes; Androgenesis, Gynogenesis, Polyploidy- their role and utility in Aquaculture; Sex-reversal in Fishes. Fish as resource for genetic research (Zebra fish).
6. Common Diseases in Edible and Ornamental Fishes: Viral, bacterial, fungal, protozoan, helminthes and crustaceans- their symptoms and control remedies.
7. Coldwater/Hill-stream fishery: Characteristics of Coldwater/Hill-stream bodies, major genera of coldwater/Hill-stream fishes with examples from North Bengal.
8. Mariculture- Definition and Scope; Basic ideas on Molluscan (Pearls and Edible Oysters).
9. Basic concepts on the Fisheries Resources of India: Estuaries, Reservoirs. Backwaters, Brackish-waters and Lakes

Course No. T-203 (Group – A)

Full Marks:40

Cell Biology

1. The Cell Nucleus: Chromosomal DNA and its packing
2. Biomembrane Structure: Lipid composition and structural organization, Membrane proteins, Membrane Fluidity
3. Transmembrane Transport: Carrier proteins and active membrane transport (uniport, symport and antiport), membrane pumps, gated ion channels
4. Biomolecule Trafficking: Role of endoplasmic reticulum, Golgi bodies, mitochondria and molecular chaperons in trafficking; function of cytoskeleton and its role in motility.
5. Cell Signaling: G-protein coupled receptor mediated, enzyme linked cell surface receptor mediated signaling and second messengers
6. Cell cycle and its regulation
7. Apoptosis: Receptor-mediated and mitochondria mediated apoptotic pathways

Course No. T- 203 (Group – B) Full Marks:35**Genetics**

1. Mendelian principles and its extensions, epistasis, penetrance and expressivity and genetic maternal effect. Pedigree analysis.
2. Microbial genetics: Transformation, Conjugation, Sexduction, Transduction and mapping genes by interrupted mating
3. DNA Replication and Repair Systems: Enzymes involved, replication origin and replication fork, fidelity of replication, DNA damage and repair mechanism
4. RNA synthesis and processing: Transcription factors and machinery, formation of initiation complex, RNA polymerase, capping, elongation and termination, RNA splicing and polyadenylation.
5. Protein Synthesis: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, translational inhibitors, Post-translational modifications of proteins
6. Recombination: Concept of homologous recombination, Site specific recombination, FLR-FRT system, Cre-lox system
7. Gene Regulation: Lac Operon, Trp Operon, Lytic and Lysogeny in Bacteriophage, Methylation and Eukaryotic gene regulation.

LABORATORY COURSES**Course No. P-204 (Group – A)****Full Marks:40****Immunology & Biotechnology**

1. Collection of Plasma and Serum
2. Dissection of primary and secondary immune organs from mice
3. Preparation of single cell suspension from spleen of mice/rat.
4. Counting of viable cells through Trypan Blue Dye Exclusion Test
5. Electrophoretic separation of plasma proteins
6. Plasmid Isolation
7. Electrophoretic analyses of uncut and linearized plasmids
8. Bacterial Culture: Agar Plate

Course No. P- 204 (Group - B)

Full Marks: 35

Cell Biology and Genetics

1. Study of meiosis from grasshopper testes/onion root tip
2. Study of mitosis from bone marrow/testis of Rat/ mouse by Air/Flame dry method
3. Karyotype Preparation
4. Study of common mutants in *Drosophila*
5. Pedigree analysis of common human dominant/recessive traits (PTC, rolling tongue polydactyly, Red-Green colour blindness etc.)
6. Detection of ABO blood groups and determination of gene frequencies in human population

THIRD SEMESTER

THEORY

Course No. T- 301 (Group – A)

Full Marks:40

Taxonomy and Biosystematics

1. Concept of Species: Biological Species concept; supra and infraspecific groups,
2. Major characteristics used in taxonomy: Classical characteristics (Morphological, ecological, and physiological), Molecular characteristics (Comparison of proteins, chromosome painting, Nucleic acid base composition, nucleic acid hybridization, nucleic acid sequencing, DNA barcoding)
3. Numerical Taxonomy (Phenetics), Construction of Dendogram
4. Phylogentic classification (cladistics), Construction of phylogenetic trees, Cladograms (plesiomorphic, apomorphic, synapomorphic, symplesiomorphic, automorphies)
5. Zoological nomenclature: International code, Rules of nomenclature and its applicability

Course No. T-301 (Group- B)

Full Marks:35

Biodiversity and Wildlife

1. Definition and indices of biodiversity
2. Levels of biodiversity: genetic, species and ecosystem

3. Biodiversity act and related International conventions
4. Threats to biodiversity, sustainable development, natural resource management in changing environment
5. Classification of wildlife according to severity of threats, CITES
6. Conservation: Rationale for wildlife conservation, models of wildlife management and conservation, *In situ* and *Ex situ* conservation, Socio-economic perspective of wildlife conservation.
7. Wildlife laws and bodies: Wildlife Protection Act, National Biodiversity Authority and National Tiger Conservation Authority (NTCA)
8. Tiger Census: Methods, Trend and Criticism
9. Joint forest management: Arabari Model

Course No. T-302 (Group- A)

Full Marks:40

Developmental Biology & Gamete Biology

1. Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation
2. Genomic equivalence and differential gene expression: Proto-differentiation, Rutter & Wessel's experiment, Briggs & King's experiment, Gurdon's experiment.
3. Cell surface molecules in sperm-egg recognition in animals
4. Cell-cell communication in development.
5. Heterogamy in eukaryotes and biology of Sex determination
6. Developmental genetics in *Drosophila*.
7. *In Vitro* fertilization and embryo transfer technology
8. Stem cells and their use, Bioethics.
9. Metamorphosis and regeneration

Course No. T-302 (Group- B)

Full Marks: 35

Endocrinology

1. Pituitary gland: Hormones and regulations
2. Thyroid gland: Hormones and functions.
3. Parathyroid hormone and other regulators of calcium and Phosphorous metabolism.
4. Adrenal gland: Cortical and medullary hormones and their functions.

5. Endocrine pancreas: Hormones and their functions.
6. Hypothalamus, Pineal and Thymus glands- structures and functions
7. Hormones and reproduction: Male and female hormones and their functions.
8. Biosynthesis: Steroid hormones and some protein hormones.
9. Diseases related to hormonal deficiency/overproduction
10. Molecular mechanism of hormone actions.

ELECTIVE COURSES (SPECIAL PAPERS)

Course No. T- 303 (Group- A)

Full Marks:50

Cellular and Molecular Immunology

1. Immunoglobulin Molecules and Genes: Three dimensional structure of Immunoglobulins; Molecular Genetics of Immunoglobulin: Allelic exclusions, recombination, rearrangements and assembly (RAG-1, RAG-2)
2. B Cell activation: B-lymphocytes Receptors, B-cell receptor-triggered signaling cascade and Activation
3. T cell activation: T-lymphocyte Antigen receptors, ITAM and initial signaling mechanism, Downstream signaling (Ras-MAPK, NF-KB) and activation, Co-stimulation regulation, Negative regulation (CTLA-4 and PD-1)
4. Regulatory (FOXP3)/ Suppressor T cells
5. Regulation of Immune Response- Cytokines, Interferons, Tumor Necrosis Factor, Chemokines (CC/ CXC group), Overview of JAKS and STATS.
6. Programmed cell death (p53, Bcl-2, Bax, Caspase), Death receptor pathways of apoptosis (activated by Fas and TNF ligand)
7. Tumor Immunology: Tumor Microenvironment, Immune response to tumors, Immunosurveillance, Escape mechanism of tumor, Immunotherapy for Cancer

Course No. T-303 (Group-B)

Full Marks: 50

Molecular Cell Biology and Genetics

1. Cell/Tissue culture techniques:
 - i) Culture media, Properties and preparation,
 - ii) Primary Cell culture, Cell lines, Lymphocyte / Fibroblast culture
 - iii) Cell cycle and cell death analysis by flowcytometry and cell separation by FACS
2. Role of Mitochondria in disease progression: Mitochondrial oxidative stress; Mitochondrial DNA damage; Mitochondrial anti-oxidants; Selective autophagy (Mitophagy); Mitochondrial dynamics (Fission-Fusion)

3. Endoplasmic Reticulum stress (ER stress)
4. Prion: replication, TSE and PrPc
5. Biology of aging and its genetic control
6. Gene Function analysis: Promoter analysis (Luciferase assay), Random mutagenesis, Site specific mutagenesis, targeted mutagenesis: gene knockout and Knock-in method, Gene silencing and genome editing.
7. Molecular Virology: Gene expression and Regulation of SV 40 and HIV
8. Patterns of inheritance: Family studies, Mendelian inheritance, Multiple alleles and complex traits, Anticipation, Uniparentaldisomy, Genomic imprinting, Multifactorial Inheritance-Polygenic theory.

Course No. T-303 (Group- C)

Full marks: 50

Parasitology and Epidemiology with Artificial Intelligence Application

1. Parasites and parasitism
 - General consideration
 - Type of parasites
 - Type of hosts
 - Symbiosis and commensalisms
2. Molecular interaction between host and parasite and evasion of immunity
3. Protozoan parasites, Distribution, habit and habitat, structure, life cycle and diseases caused by *Entamoeba histolytica*, *Leishmania donovani*
4. Epidemiology of diseases of public health importance and disease control
 1. Epidemiological aspects of diseases of national importance: Malaria, Filariasis, Leishmaniasis
 2. Infectious disease Epidemiology.
5. Biological Sequence Analysis in Parasitology: Analysis of DNA and Protein sequence, Sequence alignment, Fragment assembly, Genome sequence assembly, Neural network concepts and secondary structure prediction, Probabilistic models, Evolutionary analysis

Course No. T-303 (Group-D)

Full Marks:50

Ecology

1. Principles pertaining to limiting factors: Leibig's law of the minimum, Shelford's Law of tolerance, Law of limiting factors, Factor compensation and ecotypes, Combined concept of limiting factors.

2. Concept of habitat and Niche: Habitat and microhabitat, Development of Niche concept, Niche width, Niche overlap, Diffuse competition, Niche dynamics, Niche- a property of the species or the community, Ecological equivalents, Character displacement Sympatry, Allopatry.
3. Soil: Composition, Soil profile, Soil formation, Soil classification and distribution
4. Radiation ecology: Types of ionizing radiations, Radionuclides of ecological importance, Comparative radio sensitivity, Fate of radionuclides in the environment, Fallout problems, Waste disposal.
5. Biological rhythms: Periodicity in the environment and in the organisms, Circadian rhythm- Selective advantage, Free-running activity, Temperature compensation, Ontogeny and ageing effect, Genetic control.
6. Ecosystem development: The strategy of ecosystem development, Concept of climax, Theories, Coevolution
7. Human ecology: Ecological back ground of human origin, Disruptive and directional selection, Brain evolution, Social innovation, Population ecology of man.
8. Wildlife: Values of wildlife, Principle of wildlife management, Wildlife conservation, Data base of wildlife management, Cloning and wildlife conservation.
9. El-nino, La-nina, Southern Oscillation and their ecological impact.
10. Relation between and within species.

Course No. T-303 (Group- E) Full Marks: 50

Entomology (Insect Physiology and Industrial Entomology)

1. Insect hormones: Sources, biosynthesis, transport, mode of action and regulation of their titers
2. Haemolymph, haemocytes and Insect Immunity
3. Intra-specific and inter-specific chemical and mechanical communications in insects
4. Insect flight mechanism and migration
5. Genetics of mulberry silk moth in reference to voltinism, moultinism and economic characters. Breeding strategies in Mulberry silkworms and management of its diseases and enemies.
6. Influence of environment on insect development and life cycle traits: The Degree-Day concept.
7. Mechanisms of change in insecticide susceptibility and resistance management techniques
8. Honey bee: Role in pollination and production of honey, propolis and bee-wax; extraction and preservation of honey
9. Termites: Eusocial organization, role as builders, reducers and depredators
10. Insect based drugs, dyes, food and aesthetics

Course No. T-303 (Group –E) Full marks:50

Fisheries (Applied Ichthyology and Aquaculture)

1. Fish Growth: Measurement of growth, patterns of growth (allometric, isometric, relative, absolute); Length-weight relationship; Condition factor or K-factor or Ponderal Index.
2. Fish Age: Methods of age determination: Length- Frequency method (Peterson Method)
3. Knowledge of Maturity, Fecundity and Gonado Somatic Index.
4. Fish Migration: Types and Effects of Dams on Fish Migration.
5. Fish Toxicants used in Aquaculture.
6. Fish Seed Production and Collection from nature; Different kinds of Hatcheries (Hatching happas, Glass Jar, Chinese Hatchery, LDPE hatchery)
7. Selective Breeding: Genome Manipulation; Sex-reversal; Transgenic fish; Cryopreservation.
8. Organic farming: Organic Manures and Inorganic fertilizers used in Pond fertilization
9. Composite/Polyculture/MixedFish Farming – Principles, Management practices, intermediate harvesting.
10. Fish Nutrition – Supplementary feeding; Different kinds of Processed feeds; Feed ingredients & Feed formulation; Micro-encapsulated diet; FCR and FCE; Dry & Moist feed; Medicated feed; Food energy.
11. Sewage Fed Fisheries
12. Soil and Water quality criteria for pond fish culture.

Course P-303 (Group-G) Full marks:50

Biodiversity & Wild Life Conservation

Not yet functional

LABORATORY COURSES

Course No. P-304 (Group – A) Full marks:40

Developmental Biology and Gamete Biology

1. After incubation the eggs for different days, take out the embryo and dissect out different organs, dissociate them and observe their characteristics and behavior, fix the cells.
2. Stages of development upto three layer formation in different vertebrate classes (Desirable: Study in class with fresh fish/ frog embryo)

3. Developing organs of chick in histological sections
4. Identification of regeneration stages in histological preparation (hydra/limb of amphibia)
5. Study of life cycle of *Drosophila melanogaster*

Course No. P- 304 (Group-B) Full marks:35

Endocrinology

1. Surgical techniques such as adrenalectomy, thyroidectomy, castration, etc. to be done on rats or mice.
2. *In situ* studies of endocrine organs in mammals
3. Basic techniques of histology- Tissue fixation, embedding, block preparation, sectioning, stretching and differential staining (haematoxylin- Eosin)
4. Histological studies of gonads and endocrine glands in mouse/rat
5. Histochemical localization of brain neurosecretory cells of Insect

FOURTH SEMESTER

THEORY

Course No. T-401 (Group- A)

Full Marks: 40

Biophysics & Biostatics

Biophysics

1. Assay: Definition, criteria of reliability.
2. Principles and uses of analytical instruments: Spectrophotometer, Spectrofluorometer, Mass Spectrometry
3. Microscopy: Fluorescence and Confocal Microscopy, SEM and TEM
4. Chromatography: Principles, Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography, Gel exclusion chromatography, Affinity chromatography
5. Electrophoresis: Basic principles, PAGE, Agarose gel electrophoresis, 2-D gel electrophoresis, Basic concept on Western, Southern and Northern Blotting
6. Centrifugation: Basic principles of Sedimentation, Differential and Density gradient centrifugation.
7. Crystallography and X-ray diffraction, Basic idea of NMR.

8. Radioisotope techniques: Radioactivity and half life, radioisotopes, units of radioactivity, G-M Counter, solid and liquid scintillation counter, Metabolic labelling, Applications of radioisotopes.

Biostatistics:

1. Biostatistics/Biometry: Definition and utilization in biological assays.
2. Basic Concepts of:
 - a) Terminologies used in biostatistics: Variable, Population, Data, Sample estimate.
 - b) Measures of Central Tendency
 - c) Measures of Variation
 - d) Graphical representation of data.
3. Hypothesis Testing and Student's T-test distribution.
4. Probability Distribution-Concept Probability, Binomial Distribution and Poisson Distribution
5. Simple Linear Regression and Correlation
6. Chi-Square Test.
7. Analysis of Variance.
8. Models: Definition, Classification, Usefulness.

Course No. T-401(Group-B)

Full Marks:35

Neurobiology

1. Organization of Nervous System: Origin and Differentiation of Neurons.
2. Electrical potentials Neurilemma and their molecular basis.
3. Propagation of Nerve impulse along Neuritis and their molecular basis.
4. Synapse: Synaptic transmission and Neuromodulation.
5. Integration of synaptic functions: Synaptic plasticity.
6. Neurotransmitters: Classification, synthesis, release and functions, inactivation of Neurotransmitters.
7. Brain motor mechanism: Sensory motor integration.
8. Nature of Somatic motor actions in reference to muscles.
9. Organization and functions of automatic nervous system: Hypothalamus
10. Neuro-endocrine integration: Components, orders and feedback regulation.
11. Neural basis of learning and memory.

Course No. T-402 (Group-A)

Full Marks: 40

Evolutionary Biology

1. Origin of Life: Prerequisites for the origin of life, concept of Oparin and Halden, Experiment of Miller, RNA world, Protocells
2. Emergence of evolutionary thoughts: Lamarck, Darwin-concepts of variation, adaptation, struggle, fitness and natural selection
3. Emergence of Non-Darwinism: Neutral Hypothesis.
4. Genes and phylogenetic relationships: Gene duplication and divergence, repetitive sequences, mitochondrial DNA, microsatellites, RFLPs, 16srRNA
5. Evolutionary phylogeny: homology, parallelism, convergence
6. Rate of molecular change: Molecular clock, Molecular drive
7. Speciation: Biological and Phylogenetic species concept, Patterns and Mechanism of reproductive isolation: Models of Speciation: Allopatric, Parapatric and Sympatric

Course No. T-402 (Group-B)

Full Marks:35

Population Genetics

1. Variation: Causes of Genetics Variation in natural population, Genetic polymorphism, Measures of Genetic variation.
2. Allele frequencies and Equilibrium: Hardy-Weinberg law-Assumption, Derivation and application in population genetics, Equilibrium at two or more loci and X-linked loci, Linkage disequilibrium
3. Destabilizing forces influencing allele frequencies:
 - a) Mutation and Estimation of mutation rates.
 - b) Natural Selection: Gametic Selection. Selection against recessive and recessive lethal, Selection against dominant, Heterozygote advantage.
 - c) Migration
 - d) Genetic Drift
 - e) Mutation-Selection Balance.
4. Genetic structure of population: Selection pressure, Fisher's Theorem of Natural Selection, Genetic load and Genetic death, Mutational load.
5. Inbreeding: Measure of inbreeding, Inbreeding depression, Heterosis.
6. Quantitative trait loci: Basic concept, Heritability and its estimation

ELECTIVE COURSES

Course No. T-403 (Group- A)

Full Marks: 50

Cellular and Molecular Immunology

1. Organization of MHC in mouse and human, Polymorphism, Antigen presentation and MHC restriction, HLA and disease association, HLA Typing

2. Cell migration and inflammatory response: cell surface adhesion molecules, leukocyte migration, mediators of inflammation, inflammasome, granuloma, anti-inflammatory agents.
3. Immunity to Infectious Agents: Immunity to Intracellular and extracellular bacteria, (PAMPs, TLRs, Apoptosis, Necrosis, Autophagy, Pyroptosis, ROS signaling); Immunology of HIV infection and Prevention.
4. Techniques and technologies for quantitation of immunologically relevant molecules, substances, morphology of cells and their uses for diagnostic purposes: Immunoelectrophoresis; Immunoblotting, Immunohistochemistry; Radioimmunoassay; ELISA; FACS; DNA Microarray
5. Cell Culture Basics: Cell Lines (Primary, secondary) Culture Environment, Cell Morphology, Media and serum for mammalian cell culture, Growth factors, mitogens and purified proteins, Cancer cell line maintenance *in vitro* and *in vivo*.
6. CRISPR Technology its applications and bioethics
7. Mouse as a model for human disease study (Knockout, Transgenic, SCID); Animal ethics
8. Hybridoma Technology: Use of Gene Libraries to derive monoclonal antibodies, Humanized mAb and clinical applications
9. Reproductive Immunology, HLA-G, H-Y antigen
10. Modern vaccine trails against HIV-1, malaria and tuberculosis
11. Immune ageing: mechanism and therapeutic targets

Course No. T- 403 B

Full Marks: 50

Molecular Cell Biology and Genetics

1. Protective/Adaptive response responses:
 - a) Characteristics of inflammation, molecular mechanism, Inflammatory markers
 - b) Inflammasome Complex formation
 - c) DAMPs and PAMPS
 - d) Stress response proteins: HSPs, HIF1 alfa, NRF2, NFκB and others.
2. Genomics and Proteomics
 - a) Basic concept of system biology
 - b) Concept of transcriptome and proteome,
 - c) Global study of Genome activity: Analysis of transcriptome by SAGE and Microarray technique, Mass Spectrometry, Yeast two hybrid system, single cell genomics.
3. Molecular Cell Biology Techniques

- a) Recombinant DNA Techniques: Foot printing, DNA mobility shift assay, Co-Immunoprecipitation and Chromatin Immunoprecipitation (ChIP) assay, Western blotting
4. Application of Genetic techniques:
 - a) Mapping Genome: Linkage analysis in *Drosophila*.
 - b) Linkage mapping in pedigrees in human using DNA markers-Detection & Estimation of genetic linkage, Mapping of disease gene: Positional cloning & candidate gene approach strategy.
5. Molecular Pathology: Concept, Pathogenic mutation, Loss of function mutations, Gain of function mutation, Gene to disease approach, Disease to gene approach, Chromosomal approach.
6. Elementary idea of pharmacogenetics.

Course No. T-403 (Group- C)

Full marks:50

Parasitology and Epidemiology with Artificial Intelligence Applications

1. Helminth parasites, General characters, organization and larval forms of Platyhelminthes and Nematelminthes,
2. Distribution, habit and habitat, structure, life cycle and diseases caused by
 - Plasmodium falciparum*
 - Leishmania donovani*
 - Trypanosoma brucei/cruzi*
 - Fasciola hepatica*
 - Echinococcus granulosus*
 - Schistosoma haematobium*
 - Wuchereria bancrofti*
3. Epidemiology of diseases of public health importance and disease control
 - a) Chronic disease Epidemiology
 - b) Epidemiological aspects of diseases - Non-Communicable
 - c) Emerging and Re- Emerging diseases.
 - d) National Programmes related to Communicable and Non Communicable diseases
 - e) Dengue, Swine Flu, Chikungunya
4. Artificial Intelligence and Modeling of Biological Systems: Concepts and principles of modeling: Limitations of models, Models of behavior, Modelling in Epidemiology and Public Health SIR models, Introduction to Artificial Intelligence –basics like non monotonic logic Planning Perception Learning Neural Networks Natural language processing Expert system.
5. Village Placement Programme

Cooch Behar is a very backward district where a majority of people lives below the poverty line. The rural mass is economically and educationally backward. Thus the aim of the introduction of this village placement programme is to extend out to reach environmental awareness, hygiene and health to the rural people of this region on various aspects related to parasitic diseases. The students in their fourth semester have to visit any one of the village within the jurisdiction of Cooch Behar Panchanan Barma University and can arrange various programs to educate the rural mass in the following areas for three days.

- a) Environmental awareness,
- b) Hygiene and health
6. Bioethics and Medical ethics: Historical perspectives & Introduction to Bioethics, Ethics of clinical trials: Drug trials, vaccine trials.
7. Regulatory framework and guidelines for conduction of human research: Review processes, Institutional ethical committees, composition of committees, review procedures, WHO, UNESCO and ICMR guidelines.

Course No. T-403 (Group-D) Full marks:50

Ecology (Animal Behavior)

1. Survival value of Behavior: Experimental studies, Darwinian inclusive fitness.
2. Altruism: Kin-selection, reciprocal altruism, parental care, cooperation.
3. Role of environment in development of behavior: Interactive theory, early experience and behavioral development.
4. The nervous system and behavior: The nerve cell, sensory receptors, Neurobiology and behavior.
5. Behavioral genetics: a single gene effect, multiple gene effect, quantitative genetics, genetic techniques.
6. Mating system: Monogamy, polyandry without polygyny, polygyny.
7. Parental behavior and strategy: Rationale for greater involvement of the females, discriminating parental care, Evolution of parental favouritism.
8. Human behavior: Adaptionist approach, genetic difference and human behavior, IQ differences.

Course No. T-403 (Group-E) Full marks :50

Entomology (Insect Pest and Management)

1. Introduction to the pests of paddy, jute, mango, tea, timber and stored grains: Symptoms of their attack and crop damage.
2. Medical and forensic Entomology:
 - a) Vector biology: mode of transmission of pathogens by vectors & Controls strategies
 - b) Insects associated with cadavers with their medico-legal importance.

- c) Poisonous insects
- d) Role of insects as decomposers
- 3. Concepts of economic entomology:
 - a) Pest surveillance, sampling methods of forecasting
 - b) Economic threshold and injury level
 - c) Determination of EIL & calculation of economic decision level
- 4. Concept of biological control of pests, application of molecular tools and techniques in control.
- 5. Host plant resistance, Transgenic resistance to pests
- 6. Molecular basis of insects biotypes, barcoding technique
- 7. Case histories of successfully implemented IPM
- 8. Quarantine and legislative measures for preventing spread of pests

Course T-403 (Group-F)

Full marks:50

Fisheries (Fish Technology, and management)

1. Crafts- Principal types of fishing crafts operated in Inland and Marine waters of India
2. Gears- Classification of fishing gears; Selection of fishing gears; Types of fishing gears used in Inland and Marine waters of India; Electro= fishing
3. Fish detection methods- Basic principles of Acoustic fish detection; Echo sounder and Sonar.
4. Fish Preservation- Fundamentals of biochemistry of fish; Principles & Methods of processing and preserving fish by Refrigeration, Freezing, Drying, Salt curing, Smoking, Pickling. Use of Refrigerated Sea Water (RSW). Common defects of preserved fish products. Modern techniques employed in fish preservation.
5. Canning technology: Definition of Canning; History and Principles underlying Canning process; Can manufacture; Sterilization; Canning process of fish and prawn in India; Common defects of Canned fish products.
6. Fish by-products and their economic importance.
7. Basic aspects of National Fisheries Policy
8. Fisheries Cooperative Society- Definition of Cooperative; Origin, Structure, Aims, Role and Problems of Fisherman's Cooperative Society (Inland & Marine).

Course T-403 (Group-G)

Full marks:50

Biodiversity & Wild Life Conservation

Not yet functional

LABORATORY COURSES

Course No. P-404 (Group-A)

Full Marks:50

Cellular and Molecular Immunology

1. Learning basic cell culture techniques (Autoclaving, media/buffer Preparation and sterilization, Laminar flow use, etc.)
2. Mouse handling and studying different routes of drug administration in mouse model (oral, topical, *iv*, *ip*, *sc*, *in situ*)
3. Raising polyclonal antibody in mice against Sheep RBC, serum collection and estimating antibody titre in serum
4. Differentiate the primary and secondary antibody response in haemagglutination test by using mercaptoethanol.
5. Separation of lymphocytes in Hypaque Ficoll gradient
6. Separation of T and B cells with Nylon wool column technique
7. Estimation of cytokines by ELISA (demonstration)
8. Purification of IgG on protein A or protein G sepharose column
9. Reduced SDS PAGE
10. Immuno-blotting
11. DNA isolation; Primer designing (*in silico*) and PCR technique
12. Cell cycle analysis by flowcytometry and Interpretation of FACS results
13. Induction of solid tumors, staining and identification of ascetic tumor cells
14. Tissue sectioning (microtome & Cryomicrotome) for Immunohistochemistry
15. Visit to Institution in specialized area

Course No. P-404 (Group-B)

Full Marks: 50

Molecular Cell Biology and Genetics

1. *Drosophila* food preparation, handling of flies and Setting up of crosses
2. Study of life cycle of *Drosophila melanogaster*
3. Study of *Drosophila* mutant phenotypes.
4. Three-point test cross from gene mapping in *Drosophila*.
5. Genetic crosses in *C. elegans*.
6. Construction of Karyotype of Human/Rat.
7. Restriction digestion of Plasmid/Genomic DNA and electrophoresis. Plasmid mapping.
8. Generation of antibody in a lab animal and its detection (Titre and electrophoresis).
9. Western blotting technique.
10. Nucleotide BLAST.
11. Designing of primers (*in silico*)
12. Visit to institutions in specialized trips

Course No. P-404 (Group-C)

Full Marks: 50

Parasitology

1. Smear preparation for protozoa
2. Preparation of whole mounts for helminthes
3. Collection of parasites: Protozoans/ Nematodes/ Helminthes/ Insects.
4. Examination of different living animal hosts (domestic and wild) for collection, preservation, mounting and identification of protozoan parasites and arthropod vectors. Preparation and study of protozoan culture. Study of permanent slides of protozoan parasites and arthropod vectors; Microscopical examination of blood smears for protozoan parasites and isolation and identification of protozoan cysts and eggs of Helminth parasites from faecal samples. Use of Oculomicrometer and Stagemicrometer for measurement..
5. Examination of living animal hosts (definitive and intermediate: earthworm, cockroach, bony fish, toad, wall lizard, garden lizard, pigeon, fowl, rat etc.) for collection, preservation, and identification of different helminth parasites. Identification of helminth parasites of man. Studies of different sections (transverse, longitudinal, sagittal) of parasites by using microtomy method and Histopathological studies of different types of infected tissues of the host. Preparation of Helminth Culture. Extraction and slide preparation of nematodes from different habitats including the isolation of the entomopathogenic nematodes and sampling and estimation of population of nematodes from soil and plant tissues. Microphotography of parasites. Identification of photos of different stages of parasites and diseases.
6. Preservation and Identification of parasites: Protozoans, Nematodes, Helminthes, Insects
7. Lifecycle studies of parasites: Protozoans, Nematodes, Helminths
8. Fluorescence/ Immunofluorescence microscope studies on parasite tissues
9. Cryosectioning / Preservation/mounting of parasite tissues
10. Estimation of RNA in tissue (Colorimetric method)
11. Feulgen reaction method for DNA localization
12. Localization of RNA by methyl green pyronin –‘Y’
13. Polymerase chain reaction (Demonstration)
14. RFLP Analysis (Demonstration)
15. Biological Sequence analysis- Analysis of DNA and protein sequence
16. Modeling in Epidemiology and Public Health SIR models
17. AI applications in epidemiology-Any two

Course No. P- 404 (Group-D)

Full marks 50

Ecology and Animal Behavior

1. Study of primary productivity of a pond using light and dark bottles
2. Physic-chemical analysis of pond water
3. Succession of bacterial population in milk
4. Population studies of *Tribolium sp*
5. Learning experiment with white mouse in T-maze
6. General behavior, aggressive behavior, Dominance hierarchy studies of fish in laboratory
7. Field study of behavior of any species
8. Studies on the effect of toxic substance on liver, kidney etc of experimental animal by SDS-PAGE method
9. Comments: ecological behavior

10. Study in field/zoo/institute

Course No. P-404 (Group-E)**Full marks 50****Entomology**

1. Studies in internal morphology of
Apis: Digestive and nervous systems
Musca: male and female reproductive systems
Grasshopper : nervous and reproductive system
2. Mounting: wings mouth parts, antennae of insect pests (any three), genitalia of cockroach, bug, house fly/mosquito.
3. Preparation of key
 - a) Order level
 - b) Family levels for major orders
 - c) Collection and preparation of family level key of pests of major crops of North Bengal i.e. rice , jute, tea, vegetables
 - d) Identification of stored grain pests
4.
 - a) Quantification of water soluble protein in insects egg
 - b) Qualitative analysis of salivary and gut enzymes
 - c) Electrophoretic study of hemolymph ovarian and egg protein
5.
 - a) Host plant/seed preference study
 - b) Quantitative assay of damage of host leaf/seed caused by pest
 - c) Estimation of biochemical changes in host plant/seed due to pest injury
6.
 - a) study of insects population density (anyone species)
 - b) comparison of variance of populations of a pest species from different location and different time
 - c) determination of LD50/ LC50 values of pesticides using a pest species
 - d) Studies in species RTU/ family level diversity of insect community from crop/forest/grassland/ soil habitat
7.
 - a) Study of life cycle of pest/vector
 - b) Submission of stages of life cycle of insects and mite pests of any crop of North Bengal
8. Visit to institution/ experimental plot/ field for acquiring advanced knowledge in entomology.

Course No. P-404 (Group F)

Full Marks: 50

Fisheries (Limnology aquaculture and fisheries)

1. Collection and identification of benthic organisms (fish ponds/streams)
2. Collection of Water and Soil samples from different water bodies for the following analysis:
 - a) Physico-chemical parameters of Water and Soil quality
 - b) Primary Productivity
 - c) Quantitative and qualitative estimation of phyto- and zoo- planktons
 - d) Microbial load (Plate Count and MPM technique)
3. Determination of LC₅₀ at different hours of hill streams or rivers.
4. Determination of age in fish using scale
5. Collection and identification of Commercially important Fishes- Inland including hill streams and Marine water.
6. Study of bucco-pharyngeal region, gill-rakers, and the alimentary canal of local fishes to determine their food and feeding habits.
7. Pituitary gland extraction from head of Carp and Cat fishes and its preservation
8. Determination of Calorific Value of Fish Muscle using Wet- oxidation Method
9. Aquarium management: Setting of aquaria; fabrication; maintenance; breeding and rearing of ornamental fishes. Common diseases and their control measures.
10. Field or Institutional visit.

Course P-403 (Group-G)

Full marks:50

Biodiversity & Wild Life Conservation

Not yet functional

This syllabus has been updated with inputs from following external experts:

- Prof. Pulak Lahiri (Retired Professor), Dept. of Zoology, Calcutta University, WB, India
- Prof. Ananda Mukhopadhyay, (Retired Professor), Entomology Unit, Dept. of Zoology, University of North Bengal, WB, India
- Prof. Sudip Barat, (Retired Professor), Fishery Unit, Dept. of Zoology, University of North Bengal, WB, India
- Prof. Uday Kishore, Brunel University, London, UK

Question Pattern of Revised Zoology (Updated) Syllabus, 2019

1 st Semester	Full Marks	Objective- (Analytical Questions)	Short	Broad
Course –Theory(T) 101/102/103				
Gr-A (Theory)	40	10X2=20	2X5=10	1X10=10
Gr-B (Theory)	35	7X2=14	2X5=10	1X11=11
Course(P)-104 (Gr-A+B+C) Practical	25+25+25=75			
2 nd Semester				
Course (T) -201/202/203				
Gr-A (Theory)	40	10X2=20	2X5=10	1X10=10
Gr-B (Theory)	35	7X2=14	2X5=10	1X11=11
Course(P)-104 (Gr-A+B) Practical	40+35= 75			
3 rd Semester				
Course(T) -301/302				
Gr-A (Theory)	40	10X2=20	2X5=10	1X10=10
Gr-B (Theory)	35	7X2=14	2X5=10	1X11=11
Course- 303 (A-G)- (Theory)	50	10X2=20	2x5=10	2x10=20
Course-303 (Review/Dissertation)	25	(Manuscript submission)		
Course(P)- 304 Practical:(Gr-A+B)	40 (A)+ 35 (B)=75			
4 th Semester				
Course(T) -401/402				
Gr-A (Theory)	40	10X2=20	2X5=10	1X10=10
Gr-B (Theory)	35	7X2=14	2X5=10	1X10=11
Course- 403 (A-G)- (Theory)	50	10X2=20	2x5=10	2x10=20
Course(P)-404 (A-G) Practical	50			
Course-(S)-404 (Review/Dissertation)	50	Manuscript submission)		