Course curriculum and syllabus

2 yrs. M.Sc. in

FISHERIES SCIENCE

w.e.f. 2014-2015

Vidyasagar University

Midnapore -721102

West Bengal, India

Contents

PREFACE

The mandate of the Vidyasagar University is to plan, undertake, aid, promote and co-ordinate education, research and extension in Fisheries Science for the livelihood generation of a sizable sections of the region and our university will play a key role in fisheries education and research in the state of West Bengal, in particular and India, in general.

GENERAL INSTRUCTIONS

1. M.Sc. in Fisheries Science course is divided into four semesters each of 300 marks. There are 15 theory papers and 8 practical papers and one research paper.

2. Each semester consist of theory and practical papers, each of 50 marks consolidating to 300 marks. Each paper is subdivided into two units, each of 25 marks.

3. The students are required to complete 19 compulsory papers (13 theories and 6 practicals) and 5 optional papers designated as special papers (2 theories and 3 practicals). The optional papers will be announced at the end of the second semester examination.

4. Each theory paper to be evaluated by internal assessment – 10 marks and University semester examination - 40 marks. For each paper there will be two internal assessment examinations which will be evaluated by written test / viva-voce.

5. The students have to carry out an individual research paper of 50 marks in the fourth semester. The project will be evaluated by a project report, presentation of seminar followed by viva-voce examination.

Curriculum for M.Sc. in Fisheries Science:

TOTAL MARKS-1200	1st SEMESTER-300
	2nd SEMESTER-300
	3rd SEMESTER-300
	4th SEMESTER-300

FIRST SEMESTER:

300 Marks [Theory -200; Practical-100]

*** University Examination-80%; Internal Assessment-20%**

THEORY PAPER	UNIT	MARKS	TOPIC
FSC-101	UNIT-I	25	Freshwater fisheries resources and diversity
	UNIT- II	25	Saline water fishery resources and diversity
FSC-102	UNIT- I	25	Taxonomy and classification of fishes
	UNIT- II	25	Biology, distribution and evolution of fishes
FSC-103	UNIT- I	25	Anatomy and physiology of fin fishes
	UNIT- II	25	Anatomy and physiology of shell fishes
FSC-104	UNIT- I	25	Aquatic resources and their conservation
	UNIT- II	25	Limnology and oceanography

PRACTICAL PAPER	UNIT	MARKS	TOPIC
FSC-105	UNIT- I	25	Based on FSC -101
	UNIT- II	25	Based on FSC -102
FSC-106	UNIT- I	25	Based on FSC -103
	UNIT- II	25	Based on FSC -104

SECOND SEMESTER:

300 Marks [Theory -200; Practical-100]

University Examination-80%; Internal Assessment-20%

THEORY PAPER	UNIT	MARKS	TOPIC
FSC -201	UNIT-I	25	Freshwater ecology
	UNIT- II	25	Saline water ecology
FSC -202	UNIT- I	25	Hatchery management
	UNIT- II	25	Fish breeding
FSC -203	UNIT- I	25	Aquatic pollution and control
	UNIT- II	25	Eco-toxicology and environment
FSC-204	UNIT- I	25	Aquatic microbiology
	UNIT- II	25	Public health fishery

PRACTICAL PAPER	UNIT	MARKS	TOPIC
FSC-205	UNIT- I	25	Based on FSC-201
	UNIT- II	25	Based on FSC-202
FSC-206	UNIT- I	25	Based on FSC-203
	UNIT- II	25	Based on FSC-204

THIRD SEMESTER:

300 Marks [Theory -200; Practical-100]

University Examination-80%; Internal Assessment-20%

THEORY PAPER	UNIT	MARKS	TOPIC
FSC-301	UNIT-I	25	Fish histology and bio-chemistry
	UNIT- II	25	Bio-informatics, remote sensing and GIS
FSC-302	UNIT- I	25	Fin fish and shell fish pathology
	UNIT- II	25	Fish parasitology and immunology
FSC-303	UNIT- I	25	Nutrition of fishes
	UNIT- II	25	Fisheries technology and harbor engineering
FSC-304: SPECIAL PAPER-1 Aquaculture	UNIT- I	25	Freshwater aquaculture
	UNIT- II	25	Saline water aquaculture
FSC-304: SPECIAL PAPER-2 Fish nutrition & physiology	UNIT- I	25	Digestive physiology and feeding behavior of fin and shell fishes
	UNIT- II	25	Nutritional bioenergetics and biochemistry

PRACTICAL PAPER	UNIT	MARKS	TOPIC
FSC-305: GENERAL PAPER	UNIT- I	25	Based on FSC-301 and FSC-302 (UNIT- I)
	UNIT- II	25	Based on FSC-303 and FSC-302 (UNIT- II)
FSC-306 : **SPECIAL PAPER-1** Aquaculture	UNIT- I	25	Based on FSC-304 (UNIT- I)
	UNIT- II	25	Based on FSC-304 (UNIT- II)
FSC-306: **SPECIAL PAPER-2** Fish nutrition and physiology	UNIT- I	25	Based on FSC-304 (UNIT- I)
	UNIT- II	25	Based on FSC-304 (UNIT- II)

FOURTH SEMESTER:

300 Marks [Theory -150; Practical-150]

University Examination-80%; Internal Assessment-20%

THEORY PAPER	UNIT	MARKS	TOPIC
FSC-401	UNIT-I	25	Fish processing technology, food safety and quality assurance
	UNIT- II	25	Fisheries extension, fisheries economics and marketing
FSC-402	UNIT- I	25	Fisheries statistics and research methodology
	UNIT- II	25	Fisheries legislation, computer and its application in fisheries
FSC-403 : **SPECIAL PAPER-1** Aquaculture	UNIT- I	25	Aquaculture engineering
	UNIT- II	25	Aquaculture biotechnology
FSC-403: **SPECIAL PAPER-2** Fish nutrition and physiology	UNIT- I	25	Principles of fish nutrition and feed Technology
	UNIT- II	25	Molecular nutrition and nutraceuticals

PRACTICAL PAPER	UNIT	MARKS	TOPIC
FSC-404: GENERAL PAPER	UNIT- I	25	Based on FSC-401
	UNIT- II	25	Based on FSC-402
FSC-405: SPECIAL PAPER-1 Aquaculture	UNIT-I	25	Based on FSC-403 (UNIT-I)
	UNIT-II	25	Based on FSC-403 (UNIT-II)
FSC-405: SPECIAL PAPER-2 Fish Nutrition and physiology	UNIT-I	25	Based on FSC-403 (UNIT-I)
	UNIT-II	25	Based on FSC-403 (UNIT-II)
FSC-406 : SPECIAL PAPER-1 Aquaculture		50	Aquaculture - Research work
FSC-406: SPECIAL PAPER-2 Fish Nutrition and physiology		50	Fish Nutrition and physiology -Research work

1st SEMESTER-(300 MARKS)

THEORY -200 Marks +PRACTICAL -100 Marks

FSC-101 (50 MARKS)

[University Examination -40 and Internal Assessment-10]

UNIT- I: Freshwater Fisheries Resources and Diversity:-

1. **Inland Fisheries:** Present scenario and problems of inland fisheries. Trends in Indian aquaculture. Inland fisheries resources, major river systems of India and their fisheries. Origin, distribution, classification and ecology of lakes and their fisheries. Beel fisheries of India.

2. **Reservoir Fisheries:** Origin, distribution, classification and fishery potentialities of Indian reservoirs. Ecology and sustainable management of reservoirs. Problems and prospects of reservoir fisheries in India.

3. **Cold Water Fisheries and Invasive Fish Species:** Important cold water fisheries of India. Mahseer and Trout fisheries and their significance in sports. Invasive fish species and their impact on aquatic ecosystems.

UNIT- II: Saline water Fisheries Resources and Diversity:-

1. **Brackish Water Fisheries:** Brackish water fishery resources of India. Estuaries of India and their fisheries. Back water and their fisheries. Management of estuaries in India. Problems and prospects of brackish water fisheries in India.

2. **Marine Water Fisheries:** Capture fisheries, inshore, offshore and deep sea fisheries of Indian Sea. The major important fin fish and shell fish resources and their economic management. Marine fisheries development in India.

3. **Brackish Water and Marine Fisheries Management:** Coastal resource management. Anthropogenic activities and their impact on coastal fisheries. Management of marine fisheries in Indian context.

FSC-102 (50 MARKS)

[University Examination - 40 and Internal Assessment- 10]

UNIT- I: Taxonomy and Classification of fishes:-

1. **Taxonomy:** Definition of taxonomy, types and molecular approaches of taxonomy, Taxonomic key.

2. **Classification:** Classification of freshwater and marine fin fishes and shell fishes (Vertebrate-Sub-order; Invertebrate-Sub-class).

3. **Phylogeny:** Scope and definition. Method employed in phylogenic studies. Phylogenic tree. Fish identification and fish bar-coding.

UNIT- II: Biology, Distribution and Evolution of fishes:-

1. **Biology:** Body form, Swimming mechanism and buoyancy regulation - propulsive system. Swimming modes, Bioenergetics. Biorhythms and its significance.

2. **Evolution of fishes:** Origin and evolution of major groups of fishes, Evolutionary strategies and morphological innovation. Evolutionary genetics. Living fossils of fishes.

3. **Distribution:** Zoo-geographical realms. Distribution of fresh water and marine water fishes. General accounts of Agnathan fishes, Chimeras and Dipnoans. Migration of fishes.

FSC-103 (50 MARKS)

[University Examination – 40 and Internal Assessment- 10]

UNIT- I: Anatomy and Physiology of Fin Fishes:-

1. **Digestive and Respiratory System:** Structure and physiology of digestive and respiratory system of fin fishes. Associate digestive gland and their functions. Aquatic and aerial respiratory mechanisms. Evolutionary significance of accessory Respiratory Organ. Absorption and assimilation of nutrients. Role of hormones in the regulation of digestion. Factor affecting digestion and transport of nutrients.

2. Circulatory and Excretory System: Hematology of fin fishes. Cardiovascular physiology of fishes. Gas transport, Acid balance, Nitrogen excretion and metabolism. Osmoregulation of fin fishes.

3. Reproductive and Endocrine System: Sexual dimorphisms. Structure and physiology of reproductive system of fin fishes. Gametogenesis, Fertilization, Organogenesis and Embryonic development of fin fishes. Endocrine glands of fin fishes and their hormonal regulation.

UNIT- II: Anatomy and Physiology of Shell Fishes:-

1. Digestive and Respiratory System: Structure and physiology of digestive and respiratory system of shell fishes. Aquatic and aerial respiratory mechanisms of prawns.

2. Circulatory and Excretory System: Hematology of Shell fishes. Cardiovascular physiology of shell fishes. Excretory mechanism and osmoregulation of prawns.

3. Reproductive and Endocrine System: Structure and physiology of reproductive system of shell fishes. Embryonic development of prawn. Neuroendocrine system of prawns. Hormonal control of reproduction in shell fishes. Environmental and exogenous hormonal stimuli.

FSC-104 (50 MARKS)

[University Examination – 40 and Internal Assessment - 10]

UNIT- I: Biology of Aquatic Resources and their Conservation:-

1. **Biology of Freshwater Aquatic Resources:** Biology of freshwater fin fish and shell fishes, Indian major carps, catfishes, snake headed fishes, prawns etc. and their sustainable management.

2. **Biology of Saline water Aquatic Resources:** Biology of brackish water and marine fin fish and shell fishes. Sea- bass, Sardine, Mackerel, Hilsa, Lobster etc. Sustainable management of important saline water species.

3. **Conservation:** Definition, *Ex-situ* and *In-situ* conservation. Red Data Book, Threatened fish species. Conservation Strategies of aquatic ecosystem and faunal diversity.

UNIT- II: Limnology and Oceanography:

1. **Limnology:** Physico-chemical characteristics of freshwater**.** Lentic and Lotic aquatic ecosystem. Zonation of river, lakes and reservoirs. Productivity of river, lakes and reservoir ecosystem. Thermal stratification of lakes and reservoirs.

2. **Oceanography:** Definition, physical and chemical oceanographical analysis of Indian Ocean. Zonation of ocean. Ocean currents, waves and tides. Renewable and non renewable ocean energy.

3. **Management of Ocean:** Anthropogenic activities and their monitoring and regulation through government and nongovernment organization. Sustainable management of Indian Ocean.

PRACTICAL PAPER

FSC-105 (50 MARKS)

[University Examination -40+Internal Assessment-10]

UNIT- I: 25 Marks

1. Identification of Indian common fin fish and shell fish faunal resources from cold water, warm water, brackish water and marine water resources.
2. Biological studies of fresh water, brackish water and marine water fishes and coastal areas of India.
3. Studies of different anthropogenical activities in estuaries.

UNIT- II: 25 Marks

1. Preparation of taxonomic key and analysis of phena. Construction of phylogenetic tree.
2. Identification of Agnathan fishes, Chimera and Dipnoan fishes.
3. Study of Swimming mechanisms and buoyancy of fishes.

FSC-106 (50 MARKS)

[University Examination -40+Internal Assessment-10]

UNIT- I: 25 Marks

1. Digestive and circulatory system of 3 different species of fishes and gut content analysis.
2. Urinogenital and nervous system of 3 different species of fishes.
3. Length-Weight relationship, Gastro-Somatic index and Gonado Somatic index.

UNIT- II: 25 Marks

1. Identification of egg, spawn, fry, fingerlings of cultivable fish species and Preparation of fish-skeletons.
2. Oceanographic data analysis-Water temperature, Salinity, pH, Nutrients, Benthos and sediment characteristics; Fisheries forecasting system; Oceanographic equipments and fish finding devices.
3. Physical and chemical analysis of Pond, River, Lakes, Reservoirs and biological analysis of different water body.

2nd SEMESTER-(300 MARKS)

THEORY -200 Marks + PRACTICAL -100 Marks

FSC-201 (50 MARKS)

[University Examination - 40 and Internal Assessment-10]

UNIT- I: Freshwater Ecology:

1. **Aquatic Ecosystem:** Definition, Principles, Types and Structure of aquatic ecosystem. Abiotic and Biotic factors of aquatic ecosystem. Physico-chemical characteristics of freshwater. Classification and thermal stratification of fresh water bodies. Freshwater adaptation. Aquatic organisms and their role in carbon, nitrogen, phosphorus and sulpher cycles and impact on aquatic habitats.

2. **Wet land and Mangrove Ecosystem:** Definition, Types, Structure and Management of Wetland Ecosystem. Structure and functions of Mangrove Ecosystem. Fisheries potentialities of Wetland and Mangrove Ecosystem. Conservation and Management of Wetland and Mangrove Ecosystem.

3. **Ecosystem Management, Conservation. Productivity and Biodiversity**: Productivity of aquatic ecosystem, Primary, Gross and Net productivity. Biomass, Food chain, Food web, Energy flow and their model. Restoration, Management and conservation of aquatic ecosystem for sustainable uses. Species diversity in different ecosystem. Biodiversity indices and their significance.

UNIT- II: Saline water Ecosystem:-

1. **Estuarine Ecology:** Physico-chemical characteristics of estuarine water and soil. Types, origin, characters of Estuaries .Major estuaries of India. Management of Indian Estuary. Thermal stratification of estuary. Estuarine community and their adaptation.

2. **Marine Water Ecology:** Physico-chemical characteristics of Marine water. Classification and thermal stratification of Marine Environment. Marine communities and their adaptation. Conservation and Management of Marine Environment. Coral-reef formation and their Ecology.

3. **Coastal Ecology and Ecology of Plankton:** Structure of sea- beach, communities of sea shore and their adaptation .Conservation and Management of Indian Coastal resources. Ecology and Life history of Phytoplankton and Zooplankton. Indicator species, Predator and Prey relationship. Impact of grazing in the aquatic Ecosystem, Marine Ecology of benthic invertebrates.

FSC-202 (50 MARKS)

[University Examination -40 and Internal Assessment-10]

UNIT- I: Hatchery Management:-

1. **Design and Construction:** Site Selection and facilities required**.** Principles, layout, design and construction of different types of hatchery for seed production (Indian major carps, cat fishes, prawn, shrimp and crabs).Production of micro-algae.

2. **Water Quality Management:** Monitoring of pH, temperature, dissolved oxygen, alkalinity, salinity, free carbon di-oxide etc. in Chinese and glass jar hatchery for seed production. Aeration system and water exchange. Hatchery Standards and Bio security Sanitary and Photo Sanitary (SPS) measures. Better Management Practices (BMPs).

3. **Food and Disease Management:** Natural and Artificial feed for production of fin fish and shell fish seeds. Production of *Artemia* cysts for prawn hatchery. Occurrence of viral, bacterial, fungal pathogen and their control in the hatchery system. Packing and transport of fish seed. Current status; Problems and Prospects.

UNIT- II: Fish Breeding:-

1. **Brooder Management:** Collection and selection of brooder from different sources and their transportation. Nutrition management of brooder fish. Hormonal changes and gonadal development of brooder.

2. **Fish Reproduction:** Methods of natural and artificial fertilization. Environmental, nutritional and endocrine control of fish reproduction. Improvement of seed quality through stock up gradation. Induced breeding by synthetic hormones and its analogues. Bundh breeding and multiple breeding. Parental care of fishes.

3. **Genetic Improvement and Hybridization:** Evolution of fish karyotypes. Genetic improvement of inheritance, inbreeding and cross breeding. Types of hybridization, naturally occurring and artificially produced different types of hybrids. Cultural traits of hybrids. Genetically modified fish and its impact on aquatic environment.

FSC-203 (50 MARKS)

[University Examination -40 and Internal Assessment-10]

UNIT- I: Aquatic Pollution:

1. **Types and Sources of Aquatic Pollution:** Definition, types, sources of pollutants in different aquatic habitats. Pollution problems of ground water sources. Common transport process of pollutants in the aquatic environment, dispersal of pollutants. Waste disposal system in India and different parts of the World. Acute poisons and accumulative poisons.

2. **Impact of Pollution in Aquatic Environment:** Eutrophication and their impact on aquaculture. Algal blooms. Pollution of different aquatic body and their impact on fish health and aquatic plants (Thermal, Sewage, Pesticide, Metals, Industrial, Radioactive pollution).Aquatic contaminants and their biodegradation.

3. **Control of Pollution:** Treatment methods of Waste water, Principles of aeration, Chlorination, Ozonation and U.V. radiation. Waste recycling and utilization in aquaculture. Design and construction of water filtration devices, aerobic and anaerobic treatment of water, Prevention and control of different aquatic pollution. Methods of population survey. Role of Central and State Government in pollution control.

UNIT- II: Ecotoxicology and Environment:

1. **Environmental Toxicology:** Toxic components and their bio-transformation, Toxic kinetics and toxic dynamics. Basic mechanisms of toxicity and toxicity study. Xenobiotics, factors affecting xenobiotics action. Environmental risk assessment.

2. **Biodiversity Management:** Definition, Concepts, Factors influencing aquatic biodiversity, Types of biodiversity, Species diversity in different Eco–system, Genetic diversity and Habitat, Biodiversity indices and their significance. Concepts of Index of Biotic Integrity (IBI).Global diversity pattern and loss of biodiversity.

3. **Environment Management and their Issues:** Concepts of sustainable development. Environmental Protection Program, Stockholm UNEP, Environmental Governance in India, WTO, GATS. Population explosion, industrialization, urbanization and natural calamities. Overexploitation of resources, environmental stress, global warming, ozone depletion.

FSC-204 (50 MARKS)

[University Examination - 40 and Internal Assessment-10]

UNIT- I: Aquatic Microbiology:-

1. **Scope of Microbiology:** Scope and definition of microbiology and aquatic ecosystem. Influence of physical, chemical and biological factors on aquatic micro organisms. Role of microbes in regeneration of nutrients-conversion of Carbon, Nitrogen, Phosphorus and other nutrients. Techniques in sterilization, preparation of media. Techniques for isolation and identification of fungi, basics of mycological and virological technology.

2. **Fresh Water Microbiology:** Types, characters of psychrophilic and mesophilic bacteria. Fresh water microbes and their role in production of aquatic ecosystem. Studies of water and soil microbes. Plate culture and staining reaction of freshwater microbes.

3. **Saline Water Microbiology:** Identification, types and characters of saline water microbes. Role of microbe to enhance aquaculture productivity. Microbial population in aquatic ecosystem. Feed microbes and their impact on aquatic ecosystem.

UNIT- II: Public Health Fishery:-

1. **Aquatic Pollution:** Types and sources of aquatic pollution .BOD (Biochemical Oxygen Demand) and COD (Chemical Oxygen Demand) of different polluted water body. Aquatic contaminants and their biodegradation, biomagnifications. Impact of pollution on aquatic biota and public health significance.

2. **Environmental Impact:** Pollution and its relation to environment. EIA and its impact on aquaculture. Aquaculture and its intra- inter relationship to the environment. Sewage-fed fishery and its impact on environment.

3. **Public Health Significance:** Water–self purification, Biological factors and its control. Trickling filter, technical means of controlling microbial population in water. Use of medicines and its impact on human health. Treatment of domestic and industrial sewage for fish farming.

PRACTICAL PAPER

FSC-205 (50 MARKS)

[University Examination - 40 and Internal Assessment-10]

UNIT- I: 25 Marks

1. Collection of fauna and flora from different Ecosystem. Analysis of biodiversity community, population and species levels through different methods.
2. Determination of productivity, soil organic Carbon, Phosphorus, Potassium, Nitrogen, C/N ratio, P^H and soil microbes and texture.
3. Collection, Preservation and Identification of Coastal biological communities. Survey of different coastal zones.

UNIT- II: 25 Marks

1. Aquaculture informatics and data –base development through different market survey. Demonstration of breeding pool and hatchery. Larval rearing techniques of Indian major carps and fresh water prawn.
2. Preparation of pituitary extracts and its application in fish breeding. Breeding of cat fishes and ornamental fishes. Formulation of artificial feed for fry and fingerling of IMC.
3. Egg production and identification. Fecundity estimation. Studies of hybridization .Studies of hypophysectomy and gonadectomy of fish.

FSC-206 (50 MARKS)

[University Examination - 40 and Internal Assessment-10]

UNIT- I: 25 Marks

1. Studies of benthic epi-fauna and in-fauna of different aquatic ecosystem. Isolation, Identification and enumeration of algae and bacteria of diverse aquatic system.
2. Analysis of phytoplankton and zooplankton in different aquatic ecosystem (pond ecosystem, estuarine ecosystem, marine ecosystem).
3. Studies on wetland and mangrove ecosystem. Identification of microphytes and macrophytes of wetland ecosystem.

UNIT- II: 25 Marks

1. Estimation of BOD and COD in different aquatic ecosystem. Estimation of toxicity in different water body.
2. Isolation and culture of aquatic microbes. Gram staining. Isolation of fungal pathogen from spoiled fishes. Studies of soil microbes.
3. Physico- chemical studies of domestic sewage and urban sewage.

3rd SEMESTER-(300 MARKS)

THEORY -200 Marks + PRACTICAL -100 Marks

FSC-301 (50 MARKS)

[University Examination - 40 and Internal Assessment-10]

UNIT- I: Fish Histology and Biochemistry:-

1. **Fin Fish Histology:** Histological Structure and functions of different organs, namely-skin, kidney, liver, stomach, gonad, pituitary, hepatopancreas, intestine, gill and other associate digestive and endocrine gland.

2. **Shell Fish Histology:** Histological Structure and functions of different glands o associated with circulation, respiration, excretion and endocrine gland.

3. **Biochemistry and Metabolism:** Structure of carbohydrates, protein and lipid. Formation of ATP, TCA cycle, glycolysis, β-oxidation. Carbohydrate, protein and fat metabolism.

UNIT- II: Bioinformatics, Remote Sensing and GIS:-

1. **Concept and Application of Bioinformatics:** Definition and basic principle of bioinformatics .Field application and common biological data base .Major bioinformatics resources knowledge of various data base and bio informatics tools. Genomics and proteomics.

2. **Concept of Remote Sensing and GIS:** Definition and principle of Remote Sensing and GIS. Sensing mechanism. Analysis of images and data. Fisheries forecasting system in India and other countries .Global Positioning System (GPS).

3. **Application of Remote Sensing and GIS:** Application of Remote Sensing and GIS in Fisheries in conservation and management of fish faunal diversity and exploitation of capture fisheries. Application of Remote Sensing and GIS in coastal resource management and aquaculture.

FSC-302 (50 MARKS)

[University Examination -40 and Internal Assessment-10]

UNIT- I: Fin Fish and Shell fish Pathology and Management:-

1. **Protozoan and Viral Disease:** Causative agents, Symptoms, prophylaxis and histo pathological studies of Protozoan and viral diseases of freshwater, brackish water and marine water fin fish and shell fishes and ornamental fishes. Biology ,morphology and clinical signs associated with WSSV,YHV,TSV, IHHNV,MBV,HPV,BP,BMN,LOVV,GAV. Non infectious diseases of Shell fishes

2. **Bacterial and Fungal Disease:** Causative agents, Symptoms, prophylaxis and histo pathological studies of bacterial and fungal diseases of freshwater, brackish water and marine water fin fish and shell fishes and ornamental fishes. Bacterial diseases of shell fish, namely; vibrosis, necrotizing hepatopancreatitis, rickettsial diseases, mycobacteriosis.Life-cycle of shell fish parasites.

3. **Disease Management:** Principles of disease diagnosis, epidemiological and clinical diagnosis, microbiological and post mortem examination of fin fishes in fresh water, brackish water and marine water environment. Environmental impact of disease management. Aquaculture medicines and its importance in fisheries. Rules and regulation for use of aquaculture medicine.

UNIT-I I: Fish Parasitology and Immunology:-

1. **Parasitic Disease:** General characteristics ,epizootiology, diagnosis, life cycle of crustacean, helminthes, protozoon and metazoan parasites in freshwater, and marine water fishes.
2. **Disease Control and Management:** Host-Parasite interaction, host-pathogen, Environment relationship, Management of culture system and Environmental stress. Prevention and control of different parasitic diseases. Pathology, treatment and control of disease caused by Protozoan, Metazoan, Acanthocephalan, Crustacean and Microsporidian Parasites.
3. **Defense System in Fin Fish and Shell Fish:** Introduction to fish immunology. Defense system in fish. Innate and acquired immunity. Inflammation response to diseases. Cell mediated and humoral immunity. Lymphoid tissues and cellular components of immune systems .non-specific humoral and cellular defense mechanisms .Hypersensitivity reactions. Structures and functions of antibody. Fish vaccines and strategies for fish vaccination and vaccine production.

FSC-303 (50 MARKS)

[University Examination -40 and Internal Assessment-10]

UNIT-I: Nutrition of Fishes:

1. **Principles of Fish and shellfish Nutrition**
   Nutrients, sources, structure, classification. Metabolism of proteins, lipids, carbohydrates, nucleic acids, vitamins and minerals. Essential aminoacids, vitamins and minerals and their role in fish and shellfish nutrition.

2. **Energy nutrition :**
   Definition, energetics, expression of energy value of feed (gross energy, digestible energy, metabolizable energy, net energy), partitioning of energy and energy budget, protein energy ratio.

3. **Feed Formulations and Feed Technology:**
   Classification of feed ingredients. Antinutrients in fish feed ingredients. General principle of feed formulation, Methods of feed formulation: Pearson's method, quadratic equation linear programming, limitations. Types of feed. Hydro-stability of feed and their storage and prevention of spoilage from rancidity. Feed additives: - Classification, function, and specific use for economic and quality fish and shellfish production. Feed evaluation through the study of growth performance, FCR and PER analysis.

UNIT- II: Fisheries Technology and Harbor Engineering:

1. **Fishing Crafts and Gears:** Traditional and mechanical vessels. Inland and Marine crafts, types mechanization of crafts. Trawlers and technique of trawling. Different types of gear materials, design and fabrication of fishing gears.

2. **Operation System and Preservation:** Principles and operation of different types of Crafts and Gears used in inland and marine fishing. Mesh size regulation .Turtle Exclusion Device (TED) and preservation of Crafts and Gears.

3. **Harbor Engineering:** principles and site selection for construction of fishing harbor. Technical components of harbor design and layout. Harbors and their relationship with environment.

SPECIAL PAPER-1 (Aquaculture)
FSC-304 (50 MARKS)
[University Examination -40 and Internal Assessment-10]

UNIT- I: Freshwater Aquaculture:-

1. **Aquaculture System:** History and scope of aquaculture. Freshwater aquaculture practices in different parts of world. Global aquaculture production, consumption scenario and emerging trends. Pen, Cage, Race-way farming methods. Integrated Multi Tropic Aquaculture (IMTA). Recirculation aquaculture system, sewage-fed farming and organic aquaculture.

2. **Operational Management:** Nursery, Rearing, Pre-stocking, Stocking and Post -Stocking management of freshwater fin fish and shell fishes. Health check-up and management of freshwater fishes. Guidelines for sustainable aquaculture.

1. **Aquaculture Practices and Aquarium Keeping:** Aquaculture practices for freshwater fish: Carps, Catfishes, Snake heads, Feather back, Tilapia, Murrells, Trout, Mahseer, freshwater prawn, Pearl and Culture of frogs. Design and construction of aquarium, heating, lighting, aeration and filtration arrangements; decoration used; feed health and water quality management. Utility of Live feed for larval development of fin fish and shell fishes. Culture of different live fish food organisms and nutritive value of live feed. Live food and its importance in aquaculture.

UNIT- II: Saline Water Aquaculture:-

1. **Coastal Aquaculture:** Principle and Practices of coastal aquaculture. Status of coastal aquaculture in Globes with special emphasis on – Indian coast. Management of coastal fisheries resources and their sustainable uses. Problems and prospect of coastal fisheries in India

2. **Brackish Water Aquaculture:** Brackish water aquaculture in India, cultivable species, seed production. Scope of brackish water aquaculture in India. Problems and Prospects of brackish water aquaculture. Culture of brackish water fin fish and shell fishes.

3. **Marine Water Aquaculture:** Mari culture development in India. Production of sea-weeds of commercial importance. Mariculture practices of sea-bass, milk fish, pearl spot, grouper, snapper, breams, mullets, perches, crabs, lobsters, mussels, clams, echinoderms, prawns and marine ornamental fishes. Problems and prospect of marine fisheries in India.

SPECIAL PAPER-2 (Fish nutrition and physiology)

FSC- 304 (50 marks)

[University Examination - 40 and Internal Assessment-10]

Unit – I : 25 Marks :Digestive physiology and feeding behavior of Fish and Shellfishes

1. Digestive Physiology

Morphology, anatomy and physiology of the digestive systems of various types of fish such as herbivores, planktivores, omnivores, carnivores, detritivores, mixed diet. Nutrient digestion and digestive processes. Control and regulation of digestion. Factors affecting feed intake, digestion, absorption, assimilation. Digestive enzymes in fish; Gastric, pancreatic and intestinal secretions and role of microorganisms in digestion. Digestive hormones, nutrient regulation of endocrine functions. Digestive system of Crustaceans; Digestive organs and their role in digestion;

2. FFEED INTAKE AND FEEDING BEHAVIOUR

Modification of mouth parts of fishes due to different feeding behavior. Gustation and feeding behaviour: peripheral gestation sensation, gustatory pathways in the central nervous system, taste and feeding behavior

Feed intake: different techniques of feed intake: stomach content analysis, chemical markers, direct observation and video recording, demand feeder, X-radiography, Factors affecting feed intake, effect of feeding time on feed intake and growth, Effect of nutritional factors and feed characteristics on feed intake.

Regulation of feed intake: Nuropeptides and hormones, Inhibitory peptides, stimulator peptides, growth hormones : Feed ingestion and feeding mechanism; in crustaceans.

3. **Natural food:** Natural food for different fishes and shellfishes; Necessity of live food for larval development and culture of fish and shell fishes; Culture of different live food organisms; Prospects of live food culture. Nutritive value of live feed.

Unit – II : 25 Marks :Nutritional Bioenergetics and Biochemistry

1. Nutritional Energetic :

Introduction to bioenergetics; The energy budget equation, energy flow in fish and shellfish; Gross energy, digestive energy, metabolizable energy, net energy, heat increment; Factor influencing ingestion, absorption, excretion, respiration, and metabolism and their effect. Energy requirement of fish and factors influencing it; Estimation of energy content of feed components based on chemicals composition, indirect and direct method; Relationship between feeding and growth; energy exchange in biological system.

2. Nutritional Biochemistry

Carbohydrate : Definition, classification and biological significance of carbohdrate, Mono, di and poly saccharides: structure, properties and chemical reactions; Non-starch carbohydrates and their significance. Carbohydrate metabolism : Glycolytic pathway, TCA cycle and Pentose phosphate pathways, Gluconeogenesis, Glycogenesis and glycogenolysis. Constraints of carbohydrate utilization in fish, Strategy to enhance carbohydrate utilization.

Protein : Definition, classification and biological significance of proteins; amino acids and amino acid metabolism; transamination and deamination; urea cycle; biosynthesis of nonessential amino acids. Metabolism: digestion, Absorption, digestibility, Factors affecting protein digestibility Protein energy Inter-relationship (P/E Ratio) ; Both Qualitative and Quantitative, Protein requirement for Maintenance, Growth and Reproduction, Factors affecting protein requirement, Methods of requirement study.

Lipids : Definition, classification and biological significance of lipids, fatty acids: structure, properties and chemical reactions; saponification, iodine number and peroxide value of fats; structure, properties and functions of phospholipids, prostaglandins, PUFA (polyunsaturated fatty acids) and steroids. Lipid metabolism - biosynthesis and beta oxidation of fatty acids; Sources of lipids and fatty acids, Lipid digestibility, transport,

storage, mobilization, Protein sparing effect. Requirement study: Qualitaive and quantitative requirement of Essential fatty acids, total lipid.

3. Vitamins and Mineral Nutrition :

Vitamins: Structure and properties of water and fat soluble vitamins; Vitamin as coenzymes and prosthetic groups of enzymes. Vitamin requirements for different species, Dietary sources of vitamins, Factors affecting vitamin requirements, Menifestation of vitamin deficiency

Minerals: Macro, Trace and Toxic minerals; Minerals requirements for different aquaculture species, Dietary sources of minerals, Factors affecting mineral requirement, Menifestation of mineral deficiency.

GENERAL PRACTICAL

FSC-305 (50 MARKS)

[University Examination - 40 and Internal Assessment-10]

UNIT- I: 25 Marks

1. Histological tissue Preparation of Kidney, Liver, Stomach, Intestine, Gonad, Pituitary, Hepatopancreas etc. Fish Blood grouping and Immunity study through macrophage analysis.
2. Preparation of standard curve, buffers, physiological isolation and molecular solutions.
3. Disease diagnosis through post –mortem examination .taxonomy and identification of fish parasites. Histological and molecular techniques for disease diagnosis.

UNIT- II: 25 Marks

1. Identification of common feed ingredients, proximate analysis of feed ingredients and prepared deed and Feed formulation in the laboratory.
2. Qualitative and quantitative analysis of carbohydrates, proteins, lipids and nucleic acids.
3. Identification and preservation of different types of Crafts and Gears operated in Inland waters and Indian coast.

SPECIAL PAPER PRACTICAL

SPECIAL PAPER-1 : Aquaculture

FSC-306 (50 MARKS)

[University Examination - 40 and Internal Assessment-10]

UNIT- I: 25 Marks

1. Design and construction of different pens, raft and cages through computer. Preparation of project proposal for fish production systems.
2. Estimation of pH, DO, free CO_2, alkalinity and productivity of different fresh water and saline water body.
3. Aquarium design and construction. Culture of live fish food organisms (Phytoplankton and Zooplankton).

UNIT- II: 25 Marks

1. Studies on physical and chemical characteristics of soil. Lime and fertilizer requirement calculations in aquafarm. Visit to different aquaculture farm.

2. Analysis of organic carbon, NPK of different fish pond soil. Determination of doses of drugs for treatment of common diseases**.**

3. Studies of fish breeding and gamete preservation. Method to identify quality seeds- stress test and microscopic examination**.**

SPECIAL PAPER-2 : Fish nutrition and physiology

Paper AMT 306: (50 Marks)
[University Examination - 40 and Internal Assessment-10]

Unit – I: 25 Marks

1. Dissection and examination of digestive system of different group of Fishes. Study of digestive system of crustaceans,
2. Histological preparation of digestive organs;
3. Preparation of standard biochemical's and buffer solutions. Determination of pH of buffer solutions.
4. Qualitative and quantitative analysis of carbohydrates, proteins, lipids and nucleic acids.
5. Extraction and purification of protein. Qualitative and quantitative analysis of proteins Estimation of crude protein by Micro kjeldahl method ; Estimation of protein by Lowry's method.

Unit-II : 25 Marks

1. Assays of enzymes activity of carbohydrates, proteins and lipid digestion and metabolism
2. Estimation of Calcium and Phosphorus, Magnesium, Iron and different essential vitamins.
3. Estimation of gross and digestive energy of feed and feed ingredients; Estimation of digestibility of nutrients, Bomb- calorimetry.
4. Survey the aquafarm and market those are use aquafeed
5. Visit to aquafeed Industry.

4th SEMESTER-(300 MARKS)

THEORY -150 Marks + PRACTICAL -150 Marks

FSC-401 (50 MARKS)

[University Examination - 40 and Internal Assessment-10]

UNIT- I: Fish Processing Technology, Food Safety and Quality Assurance:

1. **Fish Handling, Ice Storage and Biochemical Aspects of Fish::** Handling and transportation of fresh fish. Handling of fish on board and hygienic handling. Icing process of fin fish and shell fishes. Freshness test by organoleptic method. Classification of ice, methods of ice production. Storage and calculation of ice requirements. Stages of fish ice. Proximate composition of fin fishes and shell fishes. Post mortem biochemical changes in fishes. Rigor mortis and freshness test. Spoilage of fishes. Spoilage indices.

2. **Fish Processing:** Principles and definition of fish freezing. Freezing curve. Individual Quick Freezing (IQF). Types of freezing, freezing process, namely- air blast freezing, plate freezing, immersion freezing and cryogenic freezing. Drip loss and Thawing of frozen fish. Concept of canning and outline of canning operation. Definition and concept of Smoking. Significance of Smoking.

3. **Food Safety of Fishery Products and Quality Assurance:** Concept of food safety in fishery products. Microbes and their role in food spoilage. Pathogenic effects of *vibrio sp, salmonella sp, Shigella sp, Staphylococcus sp* etc. Study of Psychrophilic and Mesophilic microbes. Botulism and their impact on human health. Sanitary control of processing industry and standards of sanitation and hygiene. Principles of HACCP (Hazard Analysis Critical Control Point).Formation of HACCP team and their functioning.

UNIT- II: Fisheries Extension, Fisheries Economics and Marketing:

1. **Planning, Development of Aquaculture and Fisheries Extension and Co-Operatives:** Principles and planning for aquaculture development. Types of planning, planning strategies of various levels. Plan allocation and performance of FFDA, BFDA and other aquaculture related program over the different plan period of India. Formation, Monitoring, Evaluation and Profitability of aquaculture project. Entrepreneurship development. Principles and steps of fisheries Extension. Role of NGO's in fisheries extension and development.

2. **Financial Assistance, Socio-Economic impact and Rural development:** Definition, Principle, Concept and Scope of Economics. Law of diminishing returns, law of increasing, constant and decreasing utility and returns. Financial Assistance available to fishery sector from Government, Commercial Banks, NABARD and other NGO's. Socio-Economic analysis, socio demographic profiles, socio-economic condition of fishermen in West Bengal. Fishermen folk and role of women in fisheries development.

3. **Marketing and Economy of Fishermen:** Market structure and price determination. Types of Market in India and Abroad, Law of Demand and Supply. Price determination and problems of fish marketing in India. Exports and Imports of fish and fishery products. Problems and Prospects of Export and Import. Contribution of MPEDA and other associates in exports of fish and fishery products. Marketing system and environment market opportunity identification-customer analysis. Marketing policy and market assessment.

FSC-402 (50 MARKS)

[University Examination - 40 and Internal Assessment-10]

UNIT- I: Fisheries Statistics and Research Methodology:-

1. **Concepts and Basics of Statistics:** Frequency distribution, Variance, Histogram, Pie-diagram, Bar-diagrams and Frequency curves. Concept of sample and population. Mean, Median, Mode, Standard Deviation (SD) and Standard Error of Mean (SEM).Normal and binomial distribution.

2. **Application of Fisheries Statistics:** Scope and objectives of fisheries Statistics. Sample Survey, Probability calculation, Chi-squire(X^2) test, test of Significance, Anova, Liner regression and correlation. Analysis of Variance. Fitting curves and index numbers. Statistical analysis of Biological data.

3. **Research Methodologies:** Aims and objectives of Research. Experimental design. Application of Statistical methods in Research. Formation of Research problems. Art of Dissertation/Project writing.

UNIT- II: Fisheries Legislation, Computer and Application in Fisheries:-

1. **Fisheries Legislation and Administration:** Fisheries administration in central Government and State Government. Fisheries legislation of Government of India and different maritime States. Exclusive Economic Zone (EEZ), Coastal Regulation Zone (CRZ), Integrated Coastal Zone Management (ICZM).Indian fisheries Act.1976.Coast Guard Act.1978, Martime zones of India Act.1981.Implementation of different fisheries Act. And their impact on fisheries development.

2. **Computer Hardware's and Software's:** Basic components of Computer. Central Processing Unit (CPU), Keyboard, Mouse, Peripheral devices of Computer, Computer memory and computer buses, Computer terminals. Types of Software, Monitor program and Operating System, Utility and application program, Language processor. Computer languages. High level languages etc.

3. **Application of Computer:** Problems solving and flow chart. Ward Processors-basic operation and its application .MS Power Point. Steps of Power Point Presentation. Slide preparation .Basic concepts of E –MAIL and Internet. Concepts of various Statistical packages and their application in fisheries data analysis.

SPECIAL PAPER -1: Aquaculture

FSC-403 (50 MARKS)

[University Examination -40 and Internal Assessment-10]

UNIT- I: Aquaculture Engineering:-

1. **Genetic Engineering:** Principles and practices of genetic engineering; recombinant DNA technology and gene cloning methods. Polymerase Chain Reaction (PCR), Sequencing and DNA fingerprinting. Recombinant vaccines and transgenic fish.DNA amplification and genomic DNA library. Gene therapy.

2. **Aquafarm Engineering:** Design, layout and construction of different aqua farms and aqua house. Construction and design of pond dyke and sluice gate. Water supply and drainage system. Design and fabrication of automatic feeder, aerator and bio filter. Instruments (Kits) for measuring water quality.

3. **Molecular Engineering:** Structure of DNA and RNA. DNA replication and transcription. Molecular markers (RAPD, RFLP, AFLP, ESO, SNP), ELISA, Northern blotting and Southern blotting.

UNIT- II: Aquaculture Biotechnology:-

1. **Genetic Manipulation:** Chromosome structure and its manipulation. Sex-reversal and Sex control. Role of steroid in sex reversal. Triploidy, polyploidy, Androgenesis and Gynogenesis and its application in fish culture. Hybridization techniques of fishes. Genetic resources of India and Conservation. Cryopreservation of fish gametes.

2. **Application of Biotechnology:** Hormonal manipulation in advancing maturity and reproduction. Biotechnology in aquaculture product development. Bio-fertilization and bio-fermentation. Application of biotechnology in aquaculture and fisheries management. Recombinant protein of commercial importance. IPR issues related to environmental biotechnology.

3. **Fish Cell and Tissue Culture:** General principles of cell and tissue culture. Culture of primary cell and secondary cell (sub culture). Fish cell culture and development of fish cell lines and their application. Stem cell culture.DNA markers and MHS.

SPECIAL PAPER-2 : Fish nutrition & physiology

FSC-403 (50 Marks)

[University Examination - 40 and Internal Assessment-10]

Unit – I : 25 Marks : Nutritional requirement & Feed Technology

1. Nutritional Requirements and Feeding Management:

Study the nutritional requirement of fishes and shell fishes. Body composition of fish and shellfish; Designing of nutritional experiments; experimental culture systems; Experimental diets; reference diet, purified and semi-purified diet. Methods for study the nutritional requirements in finfish and shellfish; Nutrient requirements (proteins, carbohydrates, lipids vitamins, and minerals) of warm water and cold water fish and shellfish, Larvae and brood stocks of commercial important shellfish and finfish. Factors affecting nutritional requirements of fish and shellfish; Growth evaluation: FCR, absolute growth, relative growth. SGR, % weight gain; Feed influence on body composition and quality of fish; Effect of rations on fecundity and egg quality. Feeding devices, ration size/feeding rate, feeding frequency, restricted feeding and compensatory feeding. Feeding ration; Feed dispensing methods and devices. Nutrient requirement of larvae and broodstock ; Economics of larval and broodstock feed and feeding.

2. Feed Formulation and Feed Technology :

Principles of feed formulation, feed ingredients, international coding of feed ingredients, evaluation of ingredient quality, conventional unconventional and novel ingredients, feed additives and feed binders, antinutritional factors and their prevention; Methods of feed formulation, feed processing units and processes, various feed types such as moist, semi-moist, dry, crumble, pellet, sinking, slow sinking, floating, microbound, microencapsulated, micro-coated, high energy. Fortification of micronutrients in larval and brood stock diet, exogenous enzymes in fish feed; Non-nutrient dietary component (Fibre, Ash); Low cost feed development.

3.Aquafeed Industry, Quality control end Environmental aspects :

Present status of aquafeed industry; Feed Requirements Storage and quality control: Feed storage, packaging and prevention of spoilage. Storage methods; Effect of storage on ingredient quality; Factors affecting quality of ingredients; Feed Processing Effect of processing on nutritional quality and Utilization. Feed quality, feeding and environmental pollution; Feed and its legal aspects.

Unit – II: 25 Marks: Molecular aspects of Nutrition and Neutraceticals and Nutrition and fish Health

1. Molecular nutrition

Relevance of molecular studies in nutrition; terminologies in molecular nutrition;

cell culture; nutritionally important genes; gene regulation by lipids and carbohydrates; metabolic control analysis; methodologies in molecular nutrition;

Tanscriptomics, proteomics and metabolomics; Nutrient gene interaction and expression; reverse transcription and cDNA biosynthesis; fluorescent labelled

probe preparation; microarray technique; Use of robotics in microarray; microarray nitrocellulose hybridization and labeling with P32 probes; quantitative real time polymerase chain reaction. (qRT PCR); gene expression software; relative expression software tool (REST); interpretation of microarray data; cloning technique.

2. Nutraceuticals:

Definition, classification and role of different nutraceuticals; mode of application;

functions of acidifiers (citric acid, propionic acid, benzoic acid); Exogenous enzymes (phytase, carbohydrase, proteinase) and nutrient utilisation; prebiotics and probiotics; Single cell proteins as nutraceuticals; antioxidants and their functions;

Chemoattractants for fish and shellfish; fish based neutraceticals and their application; designer fish; Immunostimulants and their functions (nucleotide, manan oligosaccharides, beta glucan, levan, bovine lactoferine, sodium alginate, levamisol). Application of biofloc technology in aquaculture.

3. Nutrition and Fish Health

Nutrients and their effects on fish health. Nutritional diseases, antinutritional factors, neutraceuticals for fish health, nutrients and immunity, nutrients and flesh quality, hyper and hypo vitaminosis. Mycotoxins in fish feed, nutritional imbalances. Dietary lipid and stress tolerance in fish larvae. Myco-toxin in fish feed. Phytase and phytate in feed ingredients.

GENERAL PRACTICAL

FSC-404 (50 MARKS)

[University Examination - 40 and Internal Assessment-10]

UNIT- I: 25 Marks

1. Fish handiling, icing, freezing of fin fish and shell fish and preparation of fish fillets.
2. Studies of proximate composition of fish, Value added product and fishery Bi-products.
3. Isolation and identification of fish spoilage causing microbes and their culture.

UNIT- II: 25 Marks

1. Testing of Goodness of fit of a continuous frequency distribution with best fitting normal distribution by Chi squire(X^2) test.
2. Operation of MS-Excel, tabulation of biological data, simple computation of different groups of data ,making chart with MS-Excel, Bar diagram, Line diagram, pie diagram for presenting biological data and correlation.
3. Application of ANOVA, Standard Deviation in practical research. Market survey, fishery Extension method and marketing of different value added product.

SPECIAL PAPER PRACTICAL
(Aquaculture)
FSC-405 (50 MARKS)

[University Examination - 40 and Internal Assessment-10]

UNIT-I: 25 Marks

1. Isolation of protein from fish blood. PCR, ELISA and blotting study for integration and expression of transgenics. Agglutination test; Gel electrophoresis.
2. Fish cell culture (primary and secondary cell culture). Identification of cell lines. Plate culture and culture of soil microbes.
3. Studies on biofermentation and biofilter. Molecular techniques in fish health management.

UNIT-II: 25 Marks

1. Protocol of cryopreservation of milt; Karyotypic studies; Isolation of DNA from fish blood.
2. Studies of fish chromosomes and different instruments and their uses. Quantitative and qualitative determination of fish gametes like sperm motility, viability, counts
3. Biotechnological manipulation in advancing maturity and reproduction. Morphological and Necropsy examination to study different internal organ of fishes.

SPECIAL PAPER PRACTICAL
(Fish nutrition and physiology)
FSC-405 (50 MARKS)

[University Examination – 40 and Internal Assessment-10]

UNIT-I: 25 Marks

1. Analysis the proximate composition of fish feed ingredients and prepared fish and shellfish feed
2. Preparation of fish and shellfish feed and ornamental fish feed using different feed ingredients.
3. Measurement of feed intake by chemical marker, Feed intake measurement with respect to temperature.
4. Estimation of growth parameters for biological evaluation. Measures of protein quality. (FCR, PER, NPU).

UNIT-II: 25 Marks

1. Estimation of different anti-metabolites or anti-nutritional factors.
2. DNA and RNA extraction and estimation.
3. Estimation of different mycotoxins
4. Study the feed probiotics and feed microbes
5. Determination of different antioxidants.
6. Single cell protein culture.

FSC-406 (50 MARKS): RESEARCH WORK

UNIT- I: 25 Marks: Research work Report:-

Each student shall have to carry out a research work (laboratory based or field based) under the guidance of a teacher for a period of minimum 3 months. Students shall have to prepare the research report in a standard format and to submit the same in triplicate before the date of examination. (Date will be announced by the department).

UNIT- II: 25 Marks: Research work Evaluation:-

The research work will be evaluated on the basis of the Seminar delivered by the student as well as Viva –Voce on the research work.