

COURSE CURRICULUM AND SYLLABUS

2 Years M.Sc. in
FISHERIES SCIENCE
w.e.f. 2018-2019



VIDYASAGAR UNIVERSITY
MIDNAPORE -721102, WEST BENGAL, INDIA

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 section 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 of two years duration and is divided into four semesters consisting of 1200 Marks (Total 24 Courses; 22 Core Courses and 2 Elective Courses). Each course has 4 credits (Total 96 Credits).
2. Each semester has 300 Marks (24 credits). Semester I, II & III has 6 courses/papers each (4 Theory courses and 2 Practical courses). The Semester-IV has three theory courses and three practical courses. Each theory course is subdivided into two units of 25 marks each (2 credits). Each practical course is of 50 marks (4 credits)
3. There is Elective Course of 100 Marks in the semester – II (50 Marks = 4 credits) and Semester – III (50 Marks = 4 credits).
4. There is a special paper, ‘Aquaculture’ in the semester III (One Theory paper = 4 credits and one practical paper = 4 credits) and in semester-IV (One Theory paper = 4 credits and one practical paper = 4 credits). The special paper will be announced at the beginning of the third semester.
5. Each theory course is to be evaluated by internal assessment – 10 marks and University semester examination - 40 marks. For each theory course/paper, there will be two internal assessment examinations which will be evaluated by written test. The practical course/paper of each semester will bear 50 marks.
6. The students have to carry out an individual dissertation paper of 50 marks (4 credits) in the fourth semester. The dissertation paper will be evaluated by a project report, presentation of seminar followed by *viva-voce* examination.

PROGRAM OUTCOME:

The department of Fishery Sciences, Vidyasagar University was to undertake and encourage the education, research and extension in Fisheries Science for the livelihood generation of a magnanimous segment of the South Bengal region of the West Bengal state particularly in the weaker sections of the communities. The course curriculum of the Fisheries Science was design in such a manner that will directly help to the passed out students for recruitment in the corporate as well as in the Govt. sectors. Therefore, thrust areas included in the syllabus are: Aquatic resources and their management, aquatic environment management and climate change, biomechanics, physiology, biochemistry of fishes, aquatic microbiology and public health fishery, genetic engineering and biotechnology, fish pathology and disease management, fisheries technology and harbor engineering are the major one. Moreover, detailed course of each unit of the all semesters will directly support to the career orientation of student for placement in the arena of the fisheries sectors.

COURSE CURRICULUM FOR M.SC. IN FISHERIES SCIENCE

TOTAL MARKS - 1200 (96 Credits)	1st SEMESTER- 300 (24 credits)	6 Core courses (4 Theory + 2 Practical courses)
	2nd SEMESTER-300 (24 credits)	5 Core courses and 1 Elective course (4 Theory + 2 Practical courses)
	3rd SEMESTER-300 (24 credits)	5 Core courses and 1 Elective course (4 Theory + 2 Practical courses)
	4th SEMESTER-300 (24 credits)	6 Core courses (3 Theory + 2 Practical courses + 1 dissertation paper)

FRAME OF THE SYLLABUS

FIRST SEMESTER

300 Marks - 24 Credits

[Core courses (Theory) - 200; Core courses (Practical) - 100]

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

THEORY PAPER	UNIT	CREDITS	MARKS	TOPIC
FSC-101 (Core course)	UNIT-1	2	25	Freshwater Fisheries Resources
	UNIT- 2	2	25	Saline water Fisheries Resources
FSC-102 (Core course)	UNIT-1	2	25	Taxonomy and Classification of fishes
	UNIT- 2	2	25	Biomechanics, Distribution and Evolution of fishes
FSC-103 (Core course)	UNIT-1	2	25	Anatomy and Physiology of Fin Fishes
	UNIT- 2	2	25	Anatomy and Physiology of Shell Fishes
FSC-104 (Core course)	UNIT-1	2	25	Biology, Biodiversity and Conservation
	UNIT- 2	2	25	Oceanography, Remote sensing & GIS

PRACTICAL PAPER	CREDITS	MARKS	TOPIC
FSC-195 (Core course)	4	50	Based on FSC -101 (Unit – 1 & 2) and FSC -102 (Unit – 1 & 2)
FSC-196 (Core course)	4	50	Based on FSC -103 (Unit – 1 & 2) and FSC -104 (Unit – 1 & 2)

SECOND SEMESTER

300 Marks - 24 Credits

[Core courses (Theory) - 150; Elective course (Theory) - 50;

Core courses (Practical) - 100]

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

THEORY PAPER	UNIT	CREDITS	MARKS	TOPIC
FSC-201 (Core course)	UNIT-1	2	25	Freshwater Ecology
	UNIT- 2	2	25	Saline water Ecology
FSC-202 (Core course)	UNIT-1	2	25	Fish Breeding
	UNIT- 2	2	25	Hatchery Design & Management
FSC-203 (Core course)	UNIT-1	2	25	Aquatic Pollution and Eco-toxicology
	UNIT- 2	2	25	Aquatic Microbiology & Public Health Fisheries
FSC-204 (Elective course)	UNIT-1	2	25	Fundamentals of Fisheries Science
	UNIT- 2	2	25	Aquaculture Management

PRACTICAL PAPER	CREDITS	MARKS	TOPIC
FSC-295 (Core course)	4	50	Based on FSC -201 (Unit – 1 & 2) and FSC -202 (Unit – 1)
FSC-296 (Core course)	4	50	Based on FSC -202 (Unit – 2) and FSC -203 (Unit – 1 & 2)

THIRD SEMESTER
300 Marks - 24 Credits
[Core courses (Theory) - 150; Elective course (Theory) - 50;
Core courses (Practical) - 100]
*** University Examination - 80%; Internal Assessment - 20%**

THEORY PAPER	UNIT	CREDITS	MARKS	TOPIC
FSC-301 (Core course)	UNIT-1	2	25	Fish Pathology and Disease Management
	UNIT- 2	2	25	Fish Parasitology and Immunology
FSC-302 (Core course)	UNIT-1	2	25	Genetic Engineering and Biotechniques
	UNIT- 2	2	25	Fisheries Technology and Harbour Engineering
FSC-303 (Core course) Special paper: Aquaculture	UNIT-1	2	25	Aquaculture Practices
	UNIT- 2	2	25	Fish Nutrition & Bioenergetics
FSC-304 (Elective course)	UNIT-1	2	25	Aquaculture Technology
	UNIT- 2	2	25	Fisheries Entrepreneurship Development

PRACTICAL PAPER	CREDITS	MARKS	TOPIC
FSC-395 (Core course) General paper	4	50	Based on FSC -301 (Unit – 1 & 2) and FSC -302 (Unit – 1 & 2)
FSC-396 (Core course) Special paper: Aquaculture	4	50	Based on FSC -303 (Unit – 1 & 2)

FOURTH SEMESTER

300 Marks - 24 Credits

[Core courses (Theory) - 150; Core courses (Practical) - 150]

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

THEORY PAPER	UNIT	CREDITS	MARKS	TOPIC
FSC-401 (Core course)	UNIT-1	2	25	Fish Processing Technology and Quality Assurance
	UNIT- 2	2	25	Fisheries Extension, Economics and Marketing
FSC-402 (Core course)	UNIT-1	2	25	Fisheries Statistics and Research Methodology
	UNIT- 2	2	25	Fisheries Legislation, Computer and Bioinformatics
FSC-403 (Core course) Special paper: Aquaculture	UNIT-1	2	25	Aquaculture Engineering & Environment Management
	UNIT- 2	2	25	Fish Genetics and Biotechnology

PRACTICAL PAPER	CREDITS	MARKS	TOPIC
FSC-494 (Core course) General paper	4	50	Based on FSC -401 (Unit – 1 & 2) and FSC -402 (Unit – 1 & 2)
FSC-495 (Core course) Special paper: Aquaculture	4	50	Based on FSC -403 (Unit – 1 & 2)
FSC-496 (Core course) Special paper: Aquaculture	4	50	Dissertation work

1st SEMESTER

(24 credits: 300 Marks)

Core course (Theory) - 200 Marks + Core course (Practical) - 100 Marks

FSC-101

(Core course - 4 credits: 50 Marks)

[University Examination - 40 and Internal Assessment-10]

UNIT- 1: Freshwater Fisheries Resources: (2 credits): 20+5 =25 Marks

Categorization of different freshwater fisheries resources. Present scenario, problems and prospects of inland fisheries. Trends in Indian fisheries. Major river systems of India and their fisheries. Current status and trend of riverine fisheries. Lake fisheries of India. Classification of reservoirs, present productivity levels and fishery potentials. Problems and prospects of reservoir fisheries in India. Measures to increase their production and economic management of reservoirs. Coldwater resources of India. Important cold-water fish species. Status of cold-water fisheries in India - Mahseer and Trout fisheries. Problems and prospects of sports fisheries in India.

Course outcome: To understand the present state of exploitation and future potential of freshwater fisheries resources, student will gain knowledge on the different inland water resources of India. Inland fish biodiversity, which is important to ecosystem function and services, is threatened by many pressures, making inland fishes one of the most endangered groups of species in the world. Learning the methodologies for assessments of inland fisheries resources is utmost necessary for the formulation of conservation methods and to adopt practices to enhance fish production. Study of current status as well as the trend of Indian inland fisheries in recent past and discussion on problems of capture and culture fisheries in Indian fisheries prospect will impact knowledge for new ideas and innovations for a sustainable management of different forms of inland fisheries resources of India.

UNIT- 2: Saline water Fisheries Resources: (2 credits): 20+5 =25 Marks

Brackish water fishery resources of India. Estuaries of India and their fisheries. Problems and management practices. Prospects of brackish water fisheries. Major fishing nations of the world,

major fishing regions. Present trend of marine capture fisheries of India. Fisheries resources of inshore, offshore and deep sea fisheries of Indian sea. Management of marine fisheries in Indian context. Important finfish and shellfish resources in demersal and pelagic systems. Important groups of finfishes and shellfishes having commercial importance.

Course outcome: To gain knowledge on the estuarine as well as marine fisheries of India, it is essential to know the estuarine fisheries as and marine fisheries resources of India. It is a major contributor for livelihood security and earning of foreign exchange by exporting fish and fishery products. This part will help in understanding the present level of exploitation of marine resources and to impart knowledge on conservation measures and also provide information on recent methodologies of sustainable exploitation of renewable resources. This part will help in understanding the major problems, and prospect of this sector in the future. As this sector provides major employment in culture, post-harvest processing, export, crafts and gear industries, student will be benefit immensely by studying various resources and their management practices.

FSC-102

(Core course - 4 credits: 50 Marks)

[University Examination - 40 and Internal Assessment- 10]

UNIT- 1: Taxonomy and Classification of fishes: (2 credits): 20+5 =25 Marks

Definition and basic concepts of biosystematics, taxonomy and classification. ICBN and scientific nomenclature. Classical taxonomy - morphometrics & meristics. Taxonomic keys. Modern techniques in Ichthyo-taxonomy. Modern taxonomical tools. Types and molecular approaches of taxonomy. Classification of freshwater and marine finfishes and shellfishes (Vertebrate up to Sub-order; Invertebrate up to Sub-class). Scope and definition. Method employed in phylogenetic studies. Phylogenetic tree. Fish identification and fish bar-coding, cataloguing.

Course outcome: This course helpful to our student to identify the fishes and study their characteristics. These basic ideas are directly related to research and aquaculture productivity.

UNIT- 2: Biomechanics, Distribution and Evolution of fishes: (2 credits): 20+5 =25 Marks

Body form, Swimming mechanism and buoyancy regulation - propulsive system. Swimming modes, Bioenergetics. Biorhythms and its significance. Zoo-geographical realms. Distribution of freshwater and marine water fishes. General accounts of Agnathan fishes, Chimeras and Dipnoans. Migration of fishes. Physiology of fish migration. Origin and evolution of major groups of fishes, Evolutionary strategies and morphological innovation. Evolutionary genetics. Living fossils of fishes.

Course outcome: Thrust of this unit is biomechanics, distribution and evolution of fishes which is very baseline information for the student of Fisheries Science required to face at the time of any interview either higher study or job recruitment.

FSC-103

(Core course - 4 credits: 50 Marks)

[University Examination – 40 and Internal Assessment- 10]

UNIT- 1: Anatomy and Physiology of Fin Fishes: (2 credits): 20+5 =25 Marks

Structure and physiology of digestive system. Associated digestive gland and their functions; Absorption and assimilation of nutrients; Hormones in the regulation of digestion; Factors affecting the process. Excretory organs in finfish and their physiological functions and mechanism of excretion. Osmoregulation in finfishes. Types of respiratory organs, gill structure. Mechanism of gaseous exchange and their transport, Accessory respiratory organs of air-breathing fishes and their evolutionary significance. Types and morphological structure of heart, blood vascular system; cardiovascular physiology and haematology of finfishes. Structure and physiology of reproductive system of finfishes. Gametogenesis, fertilization, organogenesis and embryonic development of finfishes. Endocrine glands of fin fishes, their hormones and regulation.

Course outcome: Major area of this unit is anatomy and physiology of fin fishes which is very much essential those are recruited in aquafarming system especially in Indian major carp culture.

UNIT- 2: Anatomy and Physiology of Shell Fishes: (2 credits): 20+5 =25 Marks

Anatomical structure and physiology of digestive and respiratory system of shell fishes. Mechanism of digestion and assimilation of food materials. Excretory mechanism and osmoregulation of shellfishes. Aquatic and aerial respiratory mechanisms of shellfishes. Haematology of shell fishes. Anatomical structure and cardiovascular physiology of shell fishes. Anatomical structure and physiology of reproductive system of shell fishes. Embryonic development of prawn. Neuro-endocrine system of shellfishes. Hormonal control of reproduction in shell fishes. Environmental and exogenous hormonal stimuli.

Course outcome: The foremost area of this unit is anatomy and physiology of shell fishes which is very much essential to the students those are recruited in aquafarming system especially in shrimp farming.

FSC-104

(Core course - 4 credits: 50 Marks)

[University Examination – 40 and Internal Assessment - 10]

UNIT- 1: Biology, Biodiversity and Conservation: (2 credits): 20+5 =25 Marks

Biology of commercially important freshwater, brackishwater and marine finfishes & shellfishes and their sustainable management. Definition and concept; Factors influencing aquatic biodiversity; Types of biodiversity - Species diversity in different ecosystems; Genetic Diversity and Habitat Diversity; Biodiversity indices and their significance; Concepts of Index of Biotic Integrity (IBI); Global diversity patterns and loss of biodiversity. Endangered species as per the guidelines of IUCN; Threatened aquatic species of India; Issues and strategies of conservation of aquatic species; Factors threatening indigenous species; *In-situ* and *Ex-situ* conservation. Regulations regarding introduction of exotic and invasive species and their impact on aquatic ecosystem.

Course outcome: Biology, Biodiversity conservation : This portion helps to our students to study the feeding habit, breeding habit, diversity pattern. This portion also helps to study the conservation mode of aquatic animals. This knowledge is very much helpful to aquaculture related job.

UNIT- 2 : Oceanography, Remote sensing & GIS: (2 credits): 20+5 =25 Marks

Definition, geological, physical, chemical, biological and oceanographical analysis of Indian Ocean. Zonation of ocean. Ocean currents, waves and tides. Renewable and non-renewable ocean energy. Anthropogenic activities and their monitoring and regulation through government and nongovernment organization. Sustainable management of Indian Ocean. Definition and principles of Remote Sensing and GIS. Sensing mechanism. Analysis of images and data. Fisheries forecasting system. Global Positioning System (GPS). Application of Remote Sensing, GIS in conservation, management of fish faunal diversity and exploitation of capture fisheries. Application of Remote Sensing and GIS in coastal resource management and aquaculture.

Course outcome: Oceanography, Remote sensing & GIS : In this portion we want to give idea about the ocean resources, management. It is also help to study the techniques of Remote sensing to used for coastal zone and ocean areas management. Student get job in ocean research and remote sensing.

FSC-195
PRACTICAL PAPER
(Core course - 4 credits: 50 Marks)
[University Examination – 50]

[Based on FSC -101 (Unit – 1 & 2) and FSC -102 (Unit – 1 & 2)]

- 1.** Identification of common finfishes available from different aquatic resources of India.
- 2.** Identification of common shellfishes available from different aquatic resources of India.
- 3.** Identification of Agnathan fishes, Chimera, Dipnoan and Coelacanth fishes.
- 4.** Study the morphometry of different fishes.
- 5.** Preparation of taxonomic key.
- 6.** Construction of chart regarding study of the phylogenetic tree/evolutionary tree.
- 7.** Preparation of fish bar-coding.
- 8.** Study of Swimming mechanisms and buoyancy of fishes.
- 9.** Field visit.
- 10.** Biological studies of selected finfishes and shellfishes from different aquatic resources.

Course outcome: Fish and shellfish identification is the basic requirement of fisheries students. These are very much helpful for their research oriented activity. Fish Bar coding study in one of the job oriented programme in or Private sector. Taxonomic key and evolutionary tree preparation are necessary in different evolutionary research study.

FSC-196
PRACTICAL PAPER
(Core course - 4 credits: 50 Marks)
[University Examination - 50]

[Based on FSC -103 (Unit – 1 & 2) and FSC -104 (Unit – 1 & 2)]

- 1.** Study of the digestive and circulatory systems of common species of finfishes.
- 2.** Study of the urinogenital and nervous system of different species of locally available finfishes.
- 3.** Study of the digestive and nervous system of shellfishes.
- 4.** Accessory respiratory organs of fishes.
- 5.** Study of the Length-Weight relationship, Relative gut length, Gastro-Somatic index of fish.
- 6.** Study of the feeding behavior, mouth-parts modification and gut content analysis from different fish groups.
- 7.** Study of different endocrine glands of fishes and shellfishes.
- 8.** Analysis of different biodiversity indices. (Community analysis through community map).
- 9.** Study of fish histology.
- 10.** Study of marine / brackish water zooplankton/phytoplankton.
- 11.** Fisheries forecasting system; Remote sensing equipment. PFZ analysis.
- 12.** Preparation of fish-skeletons.

Course outcome: The whole course curricula of the said paper fully based on the FSC - 103 (Unit – 1 & 2) and FSC -104 (Unit – 1 & 2) which is required for the practical experience of the students those are selected in the research field as well as farming areas.

2nd SEMESTER

(24 credits: 300 Marks)

Core course (Theory) - 150 Marks + Elective course (Theory) - 50 Marks
Core course (Practical) - 100 Marks

FSC-201

(Core course - 4 credits: 50 Marks)

[University Examination - 40 and Internal Assessment-10]

UNIT- 1: Freshwater Ecology: (2 credits): 20+5 =25 Marks

Definition, Principles, Types and structure of aquatic ecosystems. Abiotic and biotic factors. Physico-chemical characteristics of freshwater. Classification and thermal stratification of fresh water bodies. Freshwater adaptation. 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. Productivity of aquatic ecosystems - Primary, Gross and Net productivity. Biomass, Food chain, Food web, Energy flow and their model. Restoration, Management and Conservation of aquatic ecosystems for sustainable uses. Biodiversity indices and their significance.

Course outcome: The focused area of this unit is freshwater ecology which cover health of freshwater environment where sustain the aquatic life. Information of these area are very much important those are recruited in IMC based farming system.

UNIT- 2: Saline water Ecology: (2 credits): 20+5 =25 Marks

Physico-chemical characteristics of estuarine water and soil. Origin, types & characteristics of estuaries. Major estuaries of India; Management of Indian estuary. Thermal stratification of estuary. Estuarine community and their adaptation. 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 ecosystem. Marine Ecology of benthic invertebrates. Structure of sea- beach, communities of sea shore. Conservation and Management of Indian Coastal resources. Ecology and Life history of Phytoplankton and Zooplankton. Role of plankton in water colour development. Indicator species, Predator and Prey relationship. Impact of grazing in the aquatic ecosystem,

Course outcome: The foremost area of this unit is saline water ecology which cover health of saline water environment where sustain the saline water life. Information of these area are very much essential those are recruited in shrimp farming system especially tiger prawn or vannamei.

FSC-202

(Core course - 4 credits: 50 Marks)

[University Examination -40 and Internal Assessment-10]

UNIT- 1: Fish reproduction: (2 credits): 20+5 =25 Marks

Sexuality in fishes, sexual dimorphism. Reproductive cycle, fecundity and spawning. Courtship and mating. Style of reproduction. Environmental and hormonal control of reproduction. Gonad anatomy and reproductive mechanisms in important finfish and shellfish species. Factors affecting maturation and spawning. Brood availability, transport, brood raising, captive rearing and maturation. Nutritional and environmental requirement for broodstocks. Nutritional and environmental manipulation for early maturation and brood health care and stress management. Criteria for selection of brood fish. Natural collection of seed. Bundh breeding. Hypophysation technique, synthetic hormones and analogues for induced spawning, multiple breeding. Artificial breeding and seed production of commercially important shellfishes. Improvement of seed quality. Cryopreservation of gametes and embryos.

Course outcome: In recent years, major problems facing aquaculture today is the lack of knowledge of complete life cycles and mass production of seedling of targeted species. So, there is need of domestication of diversified aquaculture species. As there is a depletion of natural fish resources for various reasons, there is a need for evolving species specific technologies to culture commercially important finfish and shellfish species. The basic requirement of successful culture of any species of fish is the availability of healthy seedling in desired quantity. As the availability of seed primarily depends on the efficient functioning of the reproductive organs, it is utmost necessary for the students to understand the basic concepts of reproduction in fish and reproductive technology.

UNIT- 2: Hatchery Design & Management: (2 credits): 20+5 =25 Marks

Types of hatchery. Criteria for site selection of hatchery. Design and construction of modern hatchery. Operation, management and hatchery technology for seed production of important finfish and shell fish species. Monitoring of pH, temperature, dissolved oxygen, alkalinity, salinity, free CO₂ etc. in hatcheries for seed production. Aeration system and water exchange. Different chemicals and drugs used. Hatchery standards and bio-security. Sanitary and Phytosanitary (SPS) measures. Disease management and their control in the hatchery systems. SPF and SPR. Seed certification. Better management practices (BMPs). Seed packaging and transportation methods. Economics of seed production.

Course outcome: Healthy seedling are the key to successful aquaculture. An important factor that has contributed to the collapse of large scale farming of species traced to the

deficiencies of hatchery management. This part will help the student to understand the methods of construction of different efficient hatchery unit, broodfish calculation and different techniques to achieve target fish seed production and methods of adoption of various better management practices in hatchery system to produce quality seed and methods of transportation. Biosecurity measures in hatchery system is an important criteria for all hatchery and will help impacting knowledge for the production of certified finfish and shellfish seed in our country. Student will get benefitted by having expertise in these field and will help them to become successful entrepreneur by establishing hatchery or can achieve a successful carrier in the fish seed industry.

FSC-203

(Core course - 4 credits: 50 Marks)

[University Examination - 40 and Internal Assessment - 10]

UNIT- 1: Aquatic Pollution and Eco-toxicology: (2 credits): 20+5 =25 Marks

Definition, types, sources of pollutants. Common transport process of pollutants in the aquatic environment. Eutrophication and their impact on aquaculture. Algal blooms. EIA and its impact on aquaculture. Impact of pollution on fish health and other aquatic plants. Definitions, branches of toxicology. Historical developments, classification of poison. Types of poisoning - toxicity testing, diagnosis of poisoning. Factors modifying toxicity. Toxicokinetics and toxicodynamics. Toxicity caused by metal and non-metals and their treatment, Phytotoxins. Drug toxicity and toxicity caused by agrochemicals. Maximum Residual Limits (MRL) of various drugs and chemicals in fish metabolism. Effect of selected toxicants on aquatic life and detoxification through biotransformation. 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. Prevention and control of different aquatic pollution. Role of central and state government in pollution control. Bio-indicators for pollution.

Course outcome: Aquatic pollution and ecotoxicology : In this portion student get idea about the pollution aspects of water, waste water recycling process, impact of toxic chemicals in fish and environment. This ideas is highly essential those student work in the Government job in fisheries field.

UNIT- 2: Aquatic Microbiology & Public Health Fisheries: (2 credits): 20+5 =25 Marks

Introduction and scope of aquatic microbiology, aquatic environment as habitat for microorganisms, types of microbial interactions. Influence of physico-chemical and biological factors on aquatic micro-organisms. Microbial growth and its measurement. Types of media used for isolation and enumeration of aquatic microorganisms. Methods for identification of aquatic microbes (morphological, cultural, biochemical and molecular approach). Methods of control of microbial growth (physical and chemical). Microbial diversity in aquatic ecosystem, their characteristics and role. Biogeochemical cycle and the role of microbes in aquaculture. Concept of probiotics and prebiotics in aquaculture. Feed microbes and their impact on aquatic environment. Microbial biofilms and its significance. Biological factors of water self-purification. Microbial bioremediation. Trickling filter, technical means of controlling microbial population in water. Treatment of domestic and industrial sewage for fish culture. Sewage fed fisheries in India and its impact on environment.

Course outcome: Aquatic Microbiology & Public health fisheries : This portion helps to our student to identification of aquatic microbes and their role in fish production, Water purification process through microbes, probiotics etc. Student get job in company either as technologist or fishery microbiologist.

FSC-204

(Elective course - 4 credits: 50 Marks)

[University Examination - 40 and Internal Assessment-10]

UNIT-1: Fundamental of Fisheries Science: (2 credits): 20+5 =25 Marks

Definition and morphometric characteristics of fishes. Commercially important fin fishes and shellfishes of Indian water. Basics of aquaculture - definition and scope. Aims and objectives of aquaculture, benefits of aquaculture from human prospective. Present global and national scenario. Aquaculture *vs* Agriculture. Aquatic resources of India and their conservation and management in different water bodies.

Course outcome: The course content prepared for the CBCS student of different department to get idea about the basic information regarding fishes and their importance, gathering knowledge about importance of aquaculture.

UNIT-2: Aquaculture Management: (2 credits): 20+5 =25 Marks

Systems of aquaculture - pond culture, pen culture, tank culture, cage culture, running water culture, Sewage fed aquaculture etc. Intensification of aquaculture systems Aquaponics. Management of aquaculture pond. Monoculture and polyculture. Integrated culture systems. Backyard aquaculture. Fish for therapeutic measures. Angling as a sport. Different varieties of exotic and indigenous ornamental fishes. Culture of freshwater and saline water ornamental fishes, Management of home aquaria and their accessories. Trade of ornamental fish and export potential.

Course outcome: The course content prepared for the CBCS student of different department to get idea about the basic information regarding aquaculture management and exploitation of aquatic resources.

FSC-295
PRACTICAL PAPER
(Core course - 4 credits: 50 Marks)

[University Examination - 50]

[Based on FSC -201 (Unit – 1 & 2) and FSC -202 (Unit – 1)]

1. Determination of soil texture, organic Carbon, Phosphorus, Potassium, Nitrogen, C/N ratio, pH etc.
2. Study of the physico-chemical characteristics of freshwater: pH, Temperature, Dissolved oxygen, Productivity, Free CO₂, Hardness, Salinity, Alkalinity, Transparency, Turbidity etc.
3. Identification of different macrophytes collected from freshwater ecosystem.
4. Study of benthic community, aquatic insects from different aquatic ecosystems.
5. Analysis of phytoplankton and zooplankton from different aquatic ecosystems.
6. Dissection & display of reproductive system (male and female) of fish.
7. Dissection and display of pituitary gland preparation and preservation of pituitary gland extracts.
8. Histological & histochemical techniques to study gonads & other endocrine glands.
9. Study of the maturity stages, gonado-somatic index, fecundity, ova diameter of different fishes.
10. Cryopreservation of fish gametes.
11. Seminar presentation.

· **Course outcome:** Water and soil quality parameter study are the basic practical for the students. These studies help them to aqua farm management either as company technician or as a researcher. Aquatic insect, zooplankton, phytoplankton study helps to students for condition of aqua farm study. Fish seed production related practical helps to technical knowledge development and they are developed themselves as entrepreneur.

FSC-296
PRACTICAL PAPER
(Core course - 4 credits: 50 Marks)
[University Examination - 50]

[Based on FSC -202 (Unit – 2) and FSC -203 (Unit – 1 & 2)]

- 1.** Study of toxicity bioassay technique.
- 2.** Identification of different aquatic pollution indicator species.
- 3.** Physico-chemical analysis of waste water: total dissolved and suspended solids, H_2S , NH_3-N , PO_4 .
- 4.** Estimation of BOD and COD in different aquatic ecosystems.
- 5.** Isolation and culture of aquatic microbes.
- 6.** Identification of different types of algae.
- 7.** Gram staining.
- 8.** Studies of soil microbes, feed microbes.
- 9.** Hatchery layout and identification of equipments.
- 10.** Evaluation of quality of fish gametes.
- 11.** Study of Induced breeding technique by natural and synthetic hormones.
- 12.** Field visit.

Course outcome: The whole course curricula of the said paper fully based on the FSC - 202 (Unit – 2) and FSC -203 (Unit – 1 & 2) which is required for the practical experience of the students those are selected for higher studies as well as aquaculture sectors. Toxicity study of chemical, Microbiological analysis helps the students to engage in research in company or in Government sector Laboratories, Aquaculture Professionals, Aqua farm Technicians.

3rd SEMESTER **(24 credits: 300 Marks)**

Core course (Theory) - 150 Marks + Elective course (Theory) - 50 Marks
+ Core course (Practical) - 100 Marks

FSC-301 **(Core course - 4 credits: 50 Marks)** **[University Examination - 40 and Internal Assessment-10]**

UNIT- 1: Fish Pathology and Disease Management: (2 credits): 20+5 =25 Marks

Causative agents, symptoms, prophylaxis and histo- pathological studies of protozoan and viral diseases of freshwater, brackish water and marine water finfishes, shellfishes and ornamental fishes. Biology, morphology and clinical signs associated with viral pathogen. Non infectious diseases of shell fishes. 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 shellfish, namely; vibriosis, necrotizing hepato-pancreatitis, rickettsial diseases, mycobacteriosis. Life-cycle of shell fish parasites. 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.

Course outcome: Fish pathology and disease management : In this course we give idea to student about different disease problem faced by farmers and possible control measure, different modern aquaculture medicine. Student get job in company and Government to enrich the fish farmers about fish disease.

UNIT-2: Fish Parasitology and Immunology: (2 credits): 20+5 =25 Marks

General characteristics; Epizootiology; Diagnosis; Life cycle of crustacean, helminthes, protozoon and metazoan parasites in freshwater and marine water fishes. 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. Introduction to fish immunology. Defense system in fish. Innate and acquired immunity. 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.

Course outcome: The control of diseases and parasites in aquaculture is essential to meet the requirements of animal welfare and economic production. Parasites are not only dangerous pathogens in captive fish but also introduced parasites from other continents may pose a serious threat to fish species in wild. To comprehend the taxonomy, morphology, pathology and host-parasite relation of common parasites of aquatic organisms and to understand the significance of parasites in fish health this chapter will immensely help the student to understand the general characteristics of parasites which causes significant losses to the fisheries industries. It will help in understanding the essential principles of aquatic animal health management, biosecurity and specific issues associated with the system and to appreciate the significance of national and international instruments in quarantine, disease reporting and surveillance and their application in transboundary movement of aquatic organisms. This chapter also impact knowledge in basic principles of fish immunology, an important topic to understand the production of specific pathogen free and resistant fishes and production of vaccines useful for fishes to achieve higher production.

FSC-302

(Core course - 4 credits: 50 Marks)

[University Examination - 40 and Internal Assessment - 10]

UNIT- 1: Genetic Engineering and Biotechniques: (2 credits): 20+5 =25 Marks

Structure of DNA and RNA. Genetic code, DNA replication and transcription. Translation. Centrifugation, Electrophoresis, Isoelectrofocusing, chromatography Polymerase Chain Reaction (PCR), ELISA, Northern blotting and Southern blotting. Principles and practices of genetic engineering; recombinant DNA technology and gene cloning methods; Gene mapping; Sequencing and DNA fingerprinting; Recombinant vaccines and transgenic fish; DNA amplification and genomic DNA library; Gene therapy.

Course outcome: This part provide knowledge of basic molecular processes involving nucleic acids and protein structure, synthesis and maintenance within a living cell. The principles and practices of various instruments basically which are used in separation as well as analytical techniques used in the practical and fisheries research. The students able to understand the working principle of laboratory instruments and various molecular techniques useful for identification of fish pathogens. The bio-techniques used in the study of modern biology will help the student to register for higher education after passing out

UNIT- 2: Fisheries Technology and Harbour Engineering: (2 credits): 20+5 =25 Marks

Principles and operation of different types of Crafts and Gears used in inland and marine fishing. Design and fabrication of various fishing gears; Different types of gear materials. Traditional and mechanical vessels. Inland and marine crafts; Types of mechanization of crafts. Trawlers and technique of trawling. Preservation of Crafts and Gears. By-catch reduction devices; Turtle Exclusion Device (TED); Acoustics; Safety devices; Vessel Monitoring Systems; Satellite navigation systems; Advanced communication Systems. Principles and site selection for construction of fishing harbour. Classification and functions of fishing harbor. Design and layout of a modern fishing harbour. Harbours and their relationship with environment and fishing harbour management.

Course outcome: The thrust area of this unit is fisheries technology and harbour engineering which is essential those are recruited in fishing harbor related services in India and abroad.

FSC-303

SPECIAL PAPER (Aquaculture) (Core course - 4 credits: 50 Marks)

[University Examination -40 and Internal Assessment-10]

UNIT-1: Aquaculture Practices: (2 credits): 20+5 =25 Marks

Present status, problems and scope of fish and prawn farming in global and Indian perspective. Important cultivable freshwater species. Farming of commercially important finfish and shellfishes. Nursery and grow-out culture, pond preparation, stocking, feeding, water quality and disease management in the farming of important cultivable finfish and shellfish species. Stunted seed production and culture practice. Wastewater-fed aquaculture. Guidelines of sustainable aquaculture. Different farming systems. Important cultivable finfishes. Farming of commercially important finfish and shell fishes. Present status and scope of culture of marine mollusks in India, farming methods. Seaweed culture; emerging trends in their farming in open seas. Present status, potential of aquarium fish trade; major exporting and importing countries. Species-wise contribution of freshwater and marine fishes; marketing strategies. Aquarium management. Colour enhancement. Introduction of exotic fishes and their management. Rearing of live bearer and egg laying fishes. Problems and prospects of ornamental fish culture. Live fish feed and their importance.

Course outcome: The focused area of this unit is aquaculture practices which are the most important areas of aquaculture sectors and major recruitment took place in this areas especially in corporate house.

UNIT-2: Fish Nutrition & Bioenergetics: (2 credits): 20+5 =25 Marks

Principles of fish nutrition, nutritional requirements of cultivable finfish and shellfish. Classification and metabolism of proteins, lipids and carbohydrates. Role of nutrients like amino acids, fatty acids, proteins, lipids, carbohydrates, vitamins and minerals. Energy requirement of fishes; Bioenergetics; Factors affecting bioenergetics of fish. Optimal foraging theory, Metabolic rate, Energy budgets, Energetic efficiency of fish production. Digestion, accretions and nutrient flow; Factors affecting digestibility. Anti-nutritional factors and anti-metabolites. Microbial toxins, methods of elimination, nutrient deficiency and symptoms. Nutritional value of feed ingredients and live feed. Contribution from natural food to nutrient requirements of fish. Classification of 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 their specific use. Feed evaluation through the study of growth performance, FCR and PER analysis.

Course outcome: Fish nutrition & Bioenergetics: In this course student get idea about the feeding habit of fish, nutritional components, composition of fish feed, process of fish feed formulation. From this study students joint in fish feed company and aquaculture oriented job.

FSC-304

(Elective course - 4 credits: 50 Marks)

[University Examination -40 and Internal Assessment-10]

UNIT-1: Aquaculture Technology: (2 credits): 20+5 =25 Marks

Different types of fishing crafts gears and their accessories. Floats and sinkers; Active and passive gears; Fishing crafts and gears used in inland and marine fisheries of India. Maintenance and storage of gears and gear building materials; Nutritional value of fishes. Fish processing technology, byproducts and value added products of economic importance. Fish breeding, hybridization of fish and transgenic fishes.

Course outcome: Thrust areas of this course is aquaculture technology that was prepared for CBCS students to learned information about modern as aspects of aquaculture technology, culture procedure etc. From getting this knowledge student working in the field of aquaculture in different company.

UNIT-2: Fisheries Entrepreneurship Development: (2 credits):20+5 = 25 Marks

Fisheries extension and education in India. Fishery as a tool for rural development and employment potentiality. Different fisheries development plan/schemes in India. Role of Government, NGOs, fisheries co-operatives and other agencies in fisheries sector. Different fishery related laws in India. Planning and design of different projects related to aquaculture and their economic analysis.

Course outcome: The foremost areas of this unit is fisheries entrepreneurs development which is frame for CBCS students to get idea about how to development of entrepreneur, role of aquaculture in rural development. Role of Government and different Government plan. Students may be developed themselves as entrepreneur in the field of fisheries sector.

FSC-395
GENERAL PRACTICAL
(Core course - 4 credits: 50 Marks)
[University Examination - 50]

[Based on FSC -301 (Unit – 1 & 2) and FSC -302 (Unit – 1 & 2)]

- 1.** Identification of common bacterial, viral, protozoan and fungal diseases of finfishes & shellfishes.
- 2.** Identification of common parasites & parasitic diseases of finfishes and shellfishes.
- 3.** Studies of commonly used aquaculture medicines in West Bengal farms.
- 4.** Estimation of DNA, RNA and protein and enzyme by standard method.
- 5.** Protein profiling study of collected fish samples.
- 6.** Study of the haematological parameters of fish and fish immunity study.
- 7.** Study of the principles & applications of instruments used in modern biology.
- 8.** Identification of traditional and modern fishing crafts and gears used in different aquatic system of India
- 9.** Identification of fishing accessories (Floats/sinkers/synthetic & natural fibres/hooks/baits etc.).
- 10.** Study of the different fish finding devices.
- 11.** Identification of different fouling organisms.
- 12.** Seminar presentation.

Course outcome: The whole course curricula of the said paper fully based on the FSC - 301 (Unit – 1 & 2) and FSC -302 (Unit – 1) which is required for the practical experience of the students those are selected in the research field as well as farming areas. Study of fish microbiology, study of fish and shellfish disease, fish immunity study are very much essential for students those who will working as Field assistant or Field Technicians. Study of haematology is helpful to students those are working in the research oriented job. Fish finding device, fish catch instruments are very much related practical those student engage in such type of research.

FSC-396
SPECIAL PAPER PRACTICAL (Aquaculture)
(Core course - 4 credits: 50 Marks)
[University Examination - 50]

[Based on FSC -303 (Unit – 1 & 2)]

- 1.** Identification of common aquarium fishes (Indigenous and exotic).
- 2.** Different aquarium plants and decorative materials identification.
- 3.** Identification of weed fishes and predatory fishes.
- 4.** Construction of home aquarium and decoration and management.
- 5.** Culture of live fish food organisms.
- 6.** Identification of eggs/fry/fingerlings of important finfishes & shellfishes.
- 7.** Identification of common fish feed ingredients.
- 8.** Proximate analysis of feed ingredients.
- 9.** Feed formulation in the laboratory.
- 10.** Estimation of the energy from fish feed ingredients and prepared feed.
- 11.** Analysis of the growth, FCR, PER
- 12.** Field visit.

Course outcome: The whole course curricula of the said paper fully based on the FSC - 302 (Unit – 2) and FSC -303 (Unit – 1 & 2) which is required for the practical experience of the students those are selected for higher studies as well as aquaculture sectors. Ornamental fish is one of the popular items in fishery business. Student themselves act as entrepreneurs in this field. Feed formulation and their ingredients study are very much related to company professional job, various research jobs.

4th SEMESTER **(24 credits: 300 Marks)**

Core course (Theory) - 150 Marks; Core course (Practical) - 150 Marks

FSC-401 **(Core course - 4 credits: 50 Marks)** **[University Examination - 40 and Internal Assessment-10]**

UNIT- 1: Fish Processing Technology and Quality Assurance: (2 credits): 20+5 =25 Marks

Methods of fish handling and transportation. Proximate composition of fishes. Post mortem biochemical changes in fishes. Rigor mortis and freshness test. Spoilage of fishes. Spoilage indices. Freshness test by organoleptic method. Icing process of finfish and shellfishes. Types of ice, Storage and calculation of ice requirements. Principles of fish freezing. Freezing curve. Types of freezing employed in fish preservation. Drip loss and Thawing of frozen fish. Concept of fish packaging. Definition, composition, methods of preparation and uses of different fish byproducts having commercial importance. Definition and methods of preparation of different value-added fishery products. Antioxidant, pharmaceutical and nutraceuticals products. Concept of food safety in fishery products. Microbes and their role in food spoilage. Botulism and their impact on human health. Sanitary control of processing industry and standards of sanitation and hygiene. Quality assurance and quality control of fish and fishery products. Principles of HACCP. Formation of HACCP team and their functioning.

Course outcome: The foremost area of this unit is fish processing technology and quality assurance which explicitly required for the students those are recruited in fish processing or allied industry.

UNIT- 2: Fisheries Extension, Economics and Marketing: (2 credits): 20+5 =25 Marks

Introduction to extension education and fisheries extension-concepts, objectives and principles. History and role of fisheries extension in fisheries development; Fisheries extension methods - individual, group and mass contact methods and their effectiveness; Role of NGO's and SHGs in fisheries. Adoption and diffusion of innovations. Extension programme planning and evaluation - steps and importance. Definition, principle, concept and scope of economics. Law of demand and supply, Law of diminishing returns. Stages of production, cost concepts. Contribution of fisheries sector to National GDP. Financial Assistance available to fishery sector from Government, Commercial Banks, NABARD and other NGO's. Socio-Economic analysis, socio demographic profiles of fishermen and role of woman in fisheries development. Planning and strategies for aquaculture development. Role of FFDA, BFDA and other aquaculture related program. Aquaculture project, project cycle and appraisal of project. Entrepreneurship development. Concept of market, marketing channels, marketing functions, market structure and conduct. Types of Market, types of competition. Contract farming and

direct marketing. Price determination. Problems of fish marketing in India. Exports and imports of fish and fishery products. 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.

Course outcome: Fisheries extension, economics and marketing : In this course student get idea about transfer the technology to the rural people, economic principle and marketing process of fisheries product. This type of syllabus directly related government job

FSC-402
(Core course - 4 credits: 50 Marks)
[University Examination - 40 and Internal Assessment-10]

UNIT- 1: Fisheries Statistics and Research Methodology: (2 credits): 20+5 =25 Marks

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. Scope and objectives of fisheries statistics. Sample; Survey; Probability calculation; Chi-squire (χ^2) test; Test of significance; ANOVA; Liner regression and correlation. Analysis of Variance. Fitting curves and index numbers. Statistical analysis of biological data. Identification of problem, and formulation of objectives and hypothesis. Types of hypothesis. Testing of hypothesis. variables, data types: qualitative, quantitative; Experimental design. Application of statistical methods in Research. Methods of reporting. Use of tables, graphs, diagram, etc. in reports using computers.

Course outcome: Fisheries statistics and research methodology: Students get idea about statistical methods and their application in aquaculture research. They also benefited about the research methods. Student engages in fisheries research and development of different Government plan or in company.

UNIT- 2: Fisheries Legislation, Computer and Bioinformatics: (2 credits): 20+5 =25 Marks

Fisheries administrative setup at Centre and States. Indian Fisheries Act, 1897; The MPEDA Act, 1972; The Maritime Zone of India (regulation of fishing by foreign vessels) Act 1981; Marine Fisheries Policy, 2004; The Coastal Aquaculture Authority Act, 2005; Marine fisheries legislation in the maritime states of India; Code of Conduct for Responsible Fishing; Inland Fisheries Act; Indian wildlife (protection) Act, 1972; The Merchant Shipping Act, 1958; The Coast Guard Act, 1978. Basic components of computer. Types of software; Monitor program and operating system; Utility and application program; Computer languages. Problems solving and flow chart. MS Office (MS word, Power point, Excel); Internet browsing and communication, Statistical packages and their application in fisheries data analysis. Definition and basic principle of bioinformatics. Field of application and common biological database. Major bioinformatics resources; Knowledge of various database and bioinformatics tools. Genomics and proteomics.

Course outcome: To familiarize with the underlying importance of proper governance of the fisheries sector in India and to understand the status of fisherfolk in the country, various

administrative setup in the fisheries sector will help the student to understand the fisheries governance in the country. The student shall able to know about the Fisheries legislation in India: background, Indian Fisheries Act and subsequent amendments. The existing laws on marine fisheries sector as well as in the inland fisheries sector. This part will also provide knowledge on modern communication techniques such as Internet based technologies, video and teleconferencing, computer assisted instructions, community networks, cyber extension and e-learning and also provide knowledge to understand various database and bioinformatics tools.

FSC-403
SPECIAL PAPER (Aquaculture)
(Core course - 4 credits: 50 Marks)
[University Examination - 40 and Internal Assessment - 10]

UNIT-1: Aquaculture Engineering & Environment Management: (2 credits): 20+5 =25 Marks

Trends in global and Indian aquaculture. Extensive, semi-intensive and intensive pisciculture in pond, tank, pen and cage. Monoculture, polyculture, composite fish culture; Integrated multitrophic aquaculture, aquaponics, rotational aquaculture, organic farming. Design, farming practices, constraints of integrated farming systems (fish with paddy, cattle, pig, poultry, duck, rabbit, etc). Site selection, components and construction of different aquafarms. Design and layout of different aqua farms and aqua house. Construction and design of pond dyke, sluice gate, water supply and drainage system. Water treatment, design and fabrication of automatic feeder, aerator and bio-filter, instruments for measuring water quality. Physical and chemical properties of soil and water. Soil and water quality standards. Different kinds of fertilizers and manures and their application and their impact on environment. Biofertilizers. Ecological changes after fertilization. Primary production. Aquatic weed management.

Course outcome: The important area of this unit is aquaculture engineering & environment management which directly related to the policy of environmental health. This topic is very relevant to the aspirants those are recruited in engineering field related to fisheries as well as public health areas of NGO and Govt. sectors.

UNIT-2: Fish Genetics and Biotechnology: (2 credits): 20+5 =25 Marks

Chromosome structure; Current techniques of fish cytogenetics; Evolution of fish karyotypes; History and advancement of fish breeding, basic breeding methods and breeding programmes; Inbreeding and cross breeding; Hybridization; Chromosome manipulation. Selecting breeding; Hybridization in fishes; Chromosomal manipulation: Androgenesis and Gynogenesis, Polyploidy. Genetic resources of India and conservation. Production of monosex population and super males. Hormonal manipulation in advancing maturity and reproduction. Role of steroid in sex reversal. Application of biotechnology in aquaculture and fisheries management. Recombinant DNA, protein of commercial importance; Transgenesis. Molecular markers used in fisheries and aquaculture. IPR issues related to fish biotechnology.

Course outcome: This part shall impart knowledge on genetic basis of inheritance and breeding plans for commercially important fishes which covers Chromosome manipulation, hybridization, selective breeding, transgenesis. This will help the student to understand the production of genetically improved and transgenic fishes which is able to give higher fish production by the application of modern biotechnological procedures. The students also get an

idea about the legal rights and their advantages for the innovations of different intellectual property created by scientific communities.

FSC-494
GENERAL PRACTICAL
(Core course - 4 credits: 50 Marks)
[University Examination - 50]

[Based on FSC -401 (Unit – 1 & 2) and FSC -402 (Unit – 1 & 2)]

1. Fish handling, icing, freezing of fin fish and shellfish. Calculation of ice requirement for freezing.
2. Preparation of fish fillets.
3. Study of proximate composition of fish.
4. Preparation of value added product
5. Preparation of fish byproducts.
6. Isolation and identification of fish spoilage causing microbes and their culture.
7. Collection of data and presentation of data. Testing of Goodness of fit; Chi squire (χ^2) test and Student's t-test.
8. 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. Preparation of Power Point presentation on any topics on fisheries.
9. Database development through the survey, collection & analysis of data from fish market/ Fisheries Co-operative society / Fish farms / NGOs etc.

Course outcome: The whole course curricula of this paper is completely based on the FSC -401 (Unit – 1 & 2) and FSC -402 (Unit – 1 & Unit-2) which is required for the practical experience of different aspects the students those are selected in the research field as well as farming areas. Proximate composition analysis, value added product preparation, fish byproduct preparation etc. are very related job oriented practical those involve in the processing industry, particularly female students are very much eligible. Fisheries statistics and computer application are essential those engage in research orient job.

FSC-495

SPECIAL PAPER PRACTICAL (Aquaculture)

(Core course - 4 credits: 50 Marks)

[University Examination - 50]

[Based on FSC -403 (Unit – 1 & 2)]

1. Design and layout of different aquaculture system through computer.
2. Analysis of the aquaculture project: site, water supply, soil type, topography, drainage system, computations for water requirement, seepage and evaporation. Types of ponds and their designs.
3. Identification and working of various equipments used in aquafarm and hatchery.
4. Preparation of project proposal through chart/ model for different fish production systems.
5. Lime and fertilizer requirement calculations in aquafarm.
6. Economic analysis of carp farming & shrimp farming.
7. Study of the fish chromosome.
8. Study of hormonal manipulation in fish.
9. Study of different transgenic and hybrid fish.

Course outcome: The whole course curricula of the said paper fully based on the FSC - 403 (Unit – 1 & 2) which is required for the practical experience of the students those are selected for higher studies both in research as well as culture based recruitment. Farm design, project formulation for fisheries, calculation of different ingredients in aquaculture are very much related practical those who work directly in the farmers level as in company or Government Officials. Hybridization study, chromosome study, hormonal manipulation study in fish related practical helps to our student, those who are engage in fish genetic research.

FSC-496
Dissertation paper
(Core course - 4 credits: 50 Marks)

1. Dissertation work Report: 25 Marks:

Each student shall have to carry out a dissertation 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 dissertation report in a standard format and to submit the same in triplicate before the date of examination. (Date will be announced by the department).

2. Evaluation of dissertation work: 25 Marks:

The dissertation work will be evaluated on the basis of the seminar delivered by the student as well as *Viva Voce* on the dissertation work.

Course outcome: The individual dissertation paper is very much required to develop practical knowledge in different aspects of the fishery field that was theoretically studied. This will very much helpful to the students those are implacable future research as well as corporate job. Dissertation work will motivate to engage in research oriented job.