

**SCHEME & SYLLABUS
FOR
INDUSTRIAL FISH AND FISHERIES (IFF)**

Under
CHOICE BASED CREDIT SYSTEM (CBCS)
Assam University, Silchar

Prepared & Submitted by

Members
BUGS for Industrial Fish & Fisheries (IFF)

SCHEME & SYLLABUS FOR CHOICE BASED CREDIT SYSTEM
ON
INDUSTRIAL FISH AND FISHERIES (IFF)

Sem	Discipline Specific Core (DSC)/Generic Elective (GE)/Additional Generic Elective (AGE) Credit: 4 Marks 50	Skill Enhancement Course (SEC) Credit: 4 Marks 50	Discipline Specific Elective (DSE) Credit: 4 Marks 50
1 st	DSC-I/GE-I/AGE-I (Theory): Taxonomy & Physiology Unit-I: Basic Taxonomy Unit-II: Fish Taxonomy Unit-III: Physiology I Unit-IV: Physiology II Unit-V: Sense Organs & Endocrinology DSC-I/GE-I/AGE-I (Practical):		
2 nd	DSC-II/GE-II/AGE-II (Theory): Aquaculture & Aquatic Environment Unit-I: Basics of Aquaculture Unit-II: Aquatic Environment Unit-III: System of Aquaculture I Unit-IV: System of Aquaculture II Unit-V: Fresh Water Aquaculture DSC-II/GE-II/AGE-II (Practical):		
3 rd	DSC-III/GE-III/AGE-III (Theory): Capture Fisheries & Coastal Aquaculture Unit-I: Inland Capture Fisheries Unit-II: Marine Capture Fisheries I Unit-III: Marine Capture Fisheries II Unit-IV: Coastal Aquaculture I Unit-V: Coastal Aquaculture II DSC-III/GE-III/AGE-III (Practical):	SEC-I (Theory): Fresh Water Aquaculture Unit-I: Introduction to Aquaculture Unit-II: Construction and Management of Pond Unit-III: Aquaculture Management Unit-IV: Fish Nutrition Unit-V: Analysis of Soil & Water Quality	
4 th	DSC-IV/GE-IV/AGE-IV (Theory): Fish Reproduction, Development, Breeding Hatchery Management & Pathology Unit-I: Fish Reproduction Unit-II: Larval Development Unit-III: Fish Breeding Unit-IV: Fish Genetics Unit-V: Fish Diseases DSC-IV/GE-IV/AGE-IV (Practical):	SEC-II (Theory): Entrepreneurship Development in Fishery Unit-I: Introduction to Entrepreneurship Unit-II: Ornamental Fish Production Unit-III: Crab Culture Unit-IV: Fish Feed Production Unit-V: Production and Marketing of Processed Fish	
5 th		SEC-III(Theory): Modern Fish Culture Techniques, Pearl Culture, Biostatistics, Computer, Fishery Legislation Unit-I: Modern Fish Culture Techniques Unit-II: Pearl Culture Unit-III: Biostatistics Unit-IV: Computer Unit-V: Fishery Legislation	DSE-I (Theory): Applied Fishery-I (Aquarium Management, Post-Harvest Technology, Fish Microbiology & Aquatic Toxicology) Unit-I: Aquarium Management I Unit-II: Aquarium Management II Unit-III: Post Harvest Technology Unit-IV: Fish Microbiology Unit-V: Aquatic Toxicology DSE-I (Practical):
6 th		SEC-IV(Theory): Fish Genetics, Molecular Biology, Biotechnology, Conservation, Remote Sensing & GIS Unit-I: Fish Genetics Unit-II: Basic Molecular Biology Unit-III: Fish Biotechnology Unit-IV: Conservation of Germplasm Unit-V: Remote Sensing & GIS	DSE-II (Theory): Applied Fishery-II (Fishery Economics, Fish Marketing, Fishery Extension & Co-operative, Scope & Financing in Fishery, Disaster Management) Unit-I: Fishery Economics Unit-II: Fish Marketing Unit-III: Fishery Extension & Co-operative Unit-IV: Scopes & Financing in Fishery Unit-V: Disaster Management DSE-II (Practical):

Industrial Fish & Fisheries
DSC-I/GE-I/AGE-I (Theory)
Taxonomy & Physiology
Credit:4 Contact Hour:60 Marks: 50 (Each unit carries 10 marks)

Unit-I: Basic Taxonomy

- i) Definition of taxonomy, taxonomic terms. Role of taxonomy.
- ii) Nomenclature and its importance. Binomial nomenclature.
- iii) Difference between systematics and taxonomy, purpose of classification.
- iv) Species concept- Biological and typological, Subspecies and Sibling species

Unit-II: Fish Taxonomy & Diversity

- i) General characters and outline classification of Pisces up to order with examples.
- ii) Fish Morphometric and Meristic Characteristics
- iii) Biodiversity of Ichthyofauna of N.E. India.
- iv) Major Groups of Fishes: Major Carps, Minor carps, Catfishes, Murrels, Mullet, Live Fishes, Clupeoids etc.
- v) Morphological variation in body form, fins, body colouration scales, mouth, snouts, jaws, teeth and fins.
- vi) Scales – Types, use of scales in classification and life history

Unit-III: Fish Physiology I

- i) Food and feeding habits in fishes.
- ii) Digestive system of any Indian major carp and Scoliodon
- iii) Mechanism of digestion. Role of digestive glands in digestion.
- iv) Respiration in fishes structure of gills, air bladder, accessory respiratory organs their functions, and mechanism of respiration.

Unit-IV: Fish Physiology II

- i) Circulatory system of *Labeo rohita* & *Channa sp.*
- ii) Excretion and osmoregulation in fresh water and marine aquatic environment.
- iii) Colouration – sources of colour, colour changes, control of colour changes, significance.
- iv) Bioluminescence in Fishes.

Unit-V: Sense organs and Endocrine system

- i) Structure of brain of any teleost fish, cranial nerves in teleost.
- ii) Different type of sense organs- lateral line system, olfactory, auditory and photoreceptor.
- iii) Electricity producing organs in fishes
- iv) Mechanism of sound production in fishes
- v) Structure and function of endocrine glands in fishes- pituitary gland, thyroid, interrenal tissue. Chromaffin tissue, pancreatic islets, pheromones, urophysis, organs of stanius.

DSC-I/GE-I/AGE-I (Practical)
Credit: 2 Marks:30

1. Visual aids/ display/ model of

- i) Nervous system of Prawn
- ii) Digestive and urinogenital system of any Indian major carp.
- iii) Afferent and efferent branchial vessels of any common teleost
- iv) Accessory respiratory organ of *Clarias batrachus*, *Heteropneustes fossilis*, *Anabas sp.*, *Channa sp.*
- v) Internal ear and cranial nerves of teleost.

2. Study of prepared slides of the following:-

T.S. of stomach, intestine, gill, liver, kidney, and endocrine glands of fish

3. Permanent slide preparation:-

Students are to familiar in to the basic principle of narcotisation, fixation, staining, dehydration and mounting of the following:-

Cycloid and ctenoid scale, daphnia, cyclops, mysis

4. Qualitative and quantitative estimation of stomach content of clarias/ Channa sp.

5. Study of museum specimens:-

Prawn, Crab, Unio

Labeo rohita, *Catla catla*, *Labeo calbasu*, *Labeo gonius*, *Cirrhinus mrigala*, *Ctenopharynogodon idella*, *Hypopthalmichthys molitrix*, *Notopterus notopterus*, *Notopterus chitala*, *Amblypharyngodon mola*, *Channa punctatus*, *Clarias batrachus*, *Anabas testudineus*, *Heterpneustes fossilis*, *Xenentodon cancila*, *Mastocembalus armatus*, *Amphipnous cuchia*, *Puntius sarana*, *P. ticto*, *P. sophore*, *Chanda sp*, *Nandus sp*, *Tilapia sp*, *Rita rita*, *Ailia coilia*, *Eutropichthys vacha*, *Gudusia chapra*, *Cyprinus carpio*, *Mystus vittatus*, *Aorichthys aor*, *Wallago attu*, *Colisa sp*, *Ompok bimaculatus*, *Botia dario*, *Hippocampus*

6. Laboratory notebook

7. Viva voce.

Distribution of marks

i) Visual aids/display (Spotting & Comments)-	4
ii) Identifications (Slide & Specimens) (4x2)	8
iii) Slide Preparation	4
iv) Estimation of Stomach content	5
v) Regularity	5
vi) Laboratory notebook-	2
vii)Viva Voce	2

Total 30

DSC-II/GE-II/AGE-II (Theory)
Aquaculture & Aquatic Environment
Credit:4 Contact Hour:60 Marks: 50 (Each unit carries 10 marks)

Unit-I: Basics of Aquaculture

- i) Aquaculture – Definition, History of aquaculture
- ii) Importance of aquaculture. Present status of aquaculture
- iii) Categories of farm type and fish farming system.
- iv) Basic considerations in the selection of species for culture.
- v) Cultivable fresh water fin fishes and non-fish organism

Unit-II: Aquatic Environment

- i) Food chain, Food web & Primary productivity of aquatic ecosystem
- ii) Planktons, Nektons and Benthos-Definition, Types and Importance in Aquaculture
- iii) Water quality and soil condition of fish pond. Management of soil and water for aquaculture.
- iv) Limiting factors- definition & principles
- v) Aquatic insects & their control
- vi) Dynamics of lentic and lotic environments.

Unit-III: System of Aquaculture I

- i) Cold water and Raceway Fish Culture
- ii) Cage culture of fishes and its importance
- iii) Pen culture of fishes and its importance
- iv) Mono culture and mono sex culture
- v) Culture of fresh water prawn and pearl

Unit-IV: System of Aquaculture II

- i) Composite fish culture
- ii) Integrated fish farming- definition paddy cum fish culture, poultry cum fish culture, duck cum fish culture, piggery cum fish culture.
- iii) Air breathing and carnivorous fish culture
- iv) Sewage Fed Fish Culture, Sewage treatment techniques for fish culture and its use in Fish ponds.
- v) Organic aquaculture – elementary knowledge & its significance.

Unit-V: Fresh Water Aquaculture

- i) Types of Ponds for Fish culture. Construction and maintenance of fish farm (Hatching, Nursery, Rearing & Stocking ponds).
- ii) Pond Management-Prestocking (Liming, Fertilization etc.) and Post-stocking Management of Ponds (Feeding, Thinning, Harvesting)
- iii) Aquatic weeds & their control & importance
- iv) Algal bloom – types, bloom formation effects of algal bloom on fish.
- v) Nutritional requirements and formulation of artificial diet, storage of food. Feeding techniques to fishes
- vi) Elementary idea of Exotic Fishes, Larvivorous Fishes, Hill Stream Fishes, Predatory Fishes and Weed Fishes

DSC-II/GE-II/AGE-II (Practical)
Credit: 2 Marks: 30

1. Visual aid/ display/ model Aquaculture of different types:-

Fresh water, brackish water and marine water, Integrated Fish farming, composite fish culture, cage culture, air breathing fish culture

2. Physico-chemical analysis of soil and water:-

Temperature, moisture, texture & pH of soil

Temperature, turbidity, pH, dissolved oxygen (DO), Free Carbon dioxide of water, BOD

3. Collection and Identification of Phytoplanktons & Zooplanktons

4. Identification of predatory insects:- Dragon fly nymph, Ranatra, Corixa, Cybister, Notonecta, lithocerus, Hydaticus, Anisops, Belostoma.

5. Identification of Fish predator- Reptilia, Aves and Mammalia (At least two predators from each class)

6. Laboratory notebook

7. Viva Voce

Distribution of Marks:

i) Aquaculture Visual (Identification of Aquaculture and related comments Specifying Types of Fish Species Cultured. Different Types of Fish be Displayed in Different Aquaculture)	6
ii) Analysis of Soil and Water characteristics.	7
iii) Identification of Planktons and Aquatic Insects & Predators (4x2)	8
iv) Regularity	5
v) Laboratory Note Book	2
vi) Viva voce	2

Total 30

DSC-III/GE-III/AGE-III (Theory)
Capture Fisheries & Coastal Aquaculture
Credit:4 Contact Hour:60 Marks: 50 (Each unit carries 10 marks)

Unit-I: Inland Capture Fisheries

- i) Inland capture fishery resources of India.
- ii) Riverine fisheries of India- Brahmaputra, Ganga, Indus, East coast and west coast river system, Fisheries of Barak & Surma Rivers
- iii) Reservoir and Lacustrine fisheries-types & principal fisheries
- iv) Beel fisheries of Assam.
- v) Fishing Crafts and Gears

Unit-II: Marine Capture Fisheries I

- i) Marine Capture Fishery Resources of India
- ii) Major Pelagic and Demersal Fin Fishes
- iii) Fishing Crafts and Gears used in Marine Fish Capture

Unit-III: Marine Capture Fisheries II

- i) The EEZ Concept & its Implementation.
- ii) Coastal Regulation Zone (CRZ), Integrated Coastal Zone Management (ICZM).
- iii) Fisheries of Elasmobranchs, Oil Sardine, Bombay Duck, Prawn and Shrimp, Crab and Molluscs

Unit-IV: Coastal Aquaculture I

- i) Brackish water fisheries – Types of estuary, ecological characteristics of brackish water
- ii) principal estuaries & Principal brackish water fisheries
- iii) Chilka lake –its fisheries.
- iv) Bheries- definition, fish species cultured in bheries.

Unit-V: Coastal Aquaculture II

- i) Culture of brackish water prawn
- ii) Eye stalk ablation & its role in prawn culture
- iii) Natural feed for brackish water Prawn
- iv) Sea weed culture- Definition, important species of seaweeds, Benefits of seaweeds culture.
- v) Culture of marine edible & pearl oyster

DSC-III/GE-III/AGE-III (Practical)
Credit: 2 Marks: 30

1. Identification of the following :

Paeneus monodon, Sting ray, Torpedo, Bombay duck, Lates calcariffer, Pomfret, Scoliodon, Chanos SP. Hilasa, Stegostoma, sardinella, Pristis, Ssphyrna,

2. Visual Display/Models of Cold Water Fishes, Pearl Oyster, Clupeids. Mulletts, Catfishes, Peches, Threadfishes, Milk Fishes

3. Visual Display of Pearl Culture, Brackish water fish & Prawn Culture, Chilka Lake and its Aquaculture Practices

4. Identification of Fishing Gear and Crafts used in Marine and Fresh Water Capture

5. Laboratory Note book

6. Viva Voce

Distribution of Marks:

i)	Identification (Specimens) -	6
ii)	Visual Display/Model	9
iii)	Identification of Crafts & gears-(3x2)	6
v)	Regularity	5
vi)	Laboratory note book -	2
vii)	Viva Voce-	2
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Total		30

DSC-IV/GE-IV/AGE-IV (Theory)

Fish Reproduction, Development, Breeding, Hatchery Management & Fish Pathology

Credit:4 Contact Hour:60 Marks: 50 (Each unit carries 10 marks)

Unit-I: Fish Reproduction

- i) Male reproductive organ and its seasonal histomorphological changes and GSI (Gonado somatic index)
- ii) Female reproductive organs- different stages in the maturation of an oocyte
- iii) Maturation and spawning, Factors affecting spawning in fishes.
- iv) Sexual dimorphism, Courtship and Migration in fishes for spawning

Unit-II: Larval Development

- i) Types of Eggs, ovulation & fertilization
- ii) Gastrulation in fishes- early development
- iii) Fecundity – definition, types, Methods of estimation of fecundity.
- iv) Parental care in fishes.
- v) Growth of fish & methods of determining the growth of fish.

Unit-III: Selection & Breeding in Fishes

- i) Brood selection and its principle
- ii) Breeding habits of cultivable Fish species
- iii) Different Methods of Breeding-Inbreeding, Outbreeding, Cross Breeding, Selective Breeding and Random Breeding
- iv) Bundh Breeding-Types, Technique. Collection and Hatching of Eggs. Improvement and Problems of Bundh Breeding
- v) Induced Breeding with reference to carp, Hypophysation technique, use of Natural and Synthetic Hormones

Unit-IV: Fish Seed Rearing & Hatchery Management

- i) Different stages of seed: Spawn, Fry and Fingerlings
- ii) Fish Seed Collection from Natural Resources
- iii) Hatchery Technology
- iv) Construction of Fish Seed Farm
- v) Transport of Fish Seed, Fry, Fingerlings and Brood Fishes

Unit-V: Fish Diseases & Immunology

- i) Disease types- infections and Non infections
- ii) Infection fish disease with their remedial measure- Bacterial, Viral, Fungal, EUS, protozoon, Metazoan (Helminths, Annelids and Crustacean)
- iii) Non infections disease- Environmental, Nutritional.
- iv) Significance of fish disease in relation to aquaculture practices and fish farm management.
- v) Pathological changes in organs and tissues of fishes and diagnosis of fish disease.
- vi) Fish immunization and vaccine

DSC-IV/GE-IV/AGE-IV (Practical)

Credit: 2 Marks: 30

1. **Dissection of Pituitary gland and Preparation of pituitary extract from any Indian major carp**
2. **Identification from Slide/ Visual Aid:** T.S. of Testis and Ovary of any IMC, Blastula, Gastrula, Spawn, Fry and Fingerlings
3. **Identification of Fish Pathogens**
4. **Model/ Display/ Visual presentation of Parental care in fish**
5. **Field study:-** Students are to visit any wet land or fish farm. They are to observe fishing and collecting field data regarding species composition, crafts and gears and field problems. Submission of field report giving analysis of data, drawing of graph, Photograph etc. indicating their distribution and duly certified by the concerned teacher guide.

6. Laboratory note book

7. *Viva voce*

		<u>Distribution of Marks:</u>
i)	Pituitary Dissection & Extract preparation	6
ii)	Identification-(3x2)	6
iii)	Field Report	5
	iv) Visual Demonstration of Parental Care	4
v)	Regularity	5
vi)	Laboratory notebook-	2
vii)	Viva Voce-	2

Total - 30

SEC-I (Theory)
Fresh Water Aquaculture
Credit: 4 Marks: 50

Unit-I: Introduction to Aquaculture

- i) Aquaculture-Definition, Types. Scope & Importance of Fresh Water Aquaculture
- ii) Categories of Farm Type and Fish Farming System
- iii) Biology of exotic fishes.
- iv) Elementary idea of Larvivorous Fishes, Hill Stream Fishes, Predatory Fishes and Weed Fishes
- v) Status of Aquaculture in India.

Unit-II: Pond Construction & Management

- i) Types of Ponds for Fish culture- Hatching, Nursery, Rearing & Stocking ponds
- ii) Construction and maintenance of fish farm
- iii) Pond Management-Prestocking (Liming, Fertilization etc.)
- iv) Post-stocking Management of Ponds (Feeding, Thinning, Harvesting)

Unit-III: Aquaculture Management

- i) Aquatic weeds - significance & control
- ii) Algal bloom – types, bloom formation, effects of algal bloom on productivity of fish pond
- iii) Aquatic insects- control measures
- iv) Predatory & Weed fishes

Unit-IV: Fish Nutrition

- i) Nutritional requirements of cultivable fish and shellfish. Feed formulation and manufacturing of Artificial Feed. Storage of Feed.
- ii) Forms of feeds: wet feeds, moist feeds, dry feeds, mashes, pelleted feeds, floating and sinking pellets.
- iii) Feed additives: binders, antioxidants, enzymes, pigments, growth promoters, feed stimulants, use of preservatives and antioxidants.
- iv) Feed evaluation - feed conversion ratio, feed efficiency ratio, protein efficiency ratio, net protein utilization and biological value.
- v) Feeding techniques to fishes. Feeding Devices and Methods
- vi) Nutritional deficiency diseases.

Unit-V: Analysis of Soil & Water Quality

- i) Principles and Methods of estimation of pH and texture and Moisture content of Soil.
- ii) Principles and Methods of estimation of pH, Turbidity, Dissolved Oxygen & Dissolved Carbon dioxide of water.
- iii) Biological Oxygen Demand (BOD) & Chemical Oxygen Demand (COD)- concept and importance in Aquaculture. Methods of Estimation of BOD & COD.
- iv) Principle and Methods of Estimation of Total alkalinity, Total Hardness, Salinity, Organic Carbon, Nitrogen, Phosphate, Sulphate, Chloride.

SEC-II (Theory)
Entrepreneurship Development in Fishery
Credit: 4 Marks: 50

Unit-I: Introduction to Entrepreneurship

- i) Entrepreneurship Building: Meaning, Importance, Psychological, Sociological factors and distinctive competence. Entrepreneurship process.
- ii) Need, scope, characteristics and types of Entrepreneurship. STED.
- iii) Social responsibility and business ethics.

Unit-II: Ornamental Fish Production

- i) Commercial Production: Requirements and design for the commercial production of ornamental fishes.
- ii) Commercial production of goldfish, live bearers, gouramies, barbs and tetras, angel fish.
- iii) Natural ponds for the mass production of ornamental fishes.
- iv) Mass production of aquarium plants.

Unit-III: Crab Culture

- i) Introduction: History and Present status of crab culture.
- ii) Biology of Crabs: Economically important species of crabs.
- iii) Morphology and anatomy of crabs. Life cycle of crabs.
- iv) Crabs culture: Cultivable species of crabs in India. Techniques of Crabs culture. Crabs fattening.
- v) Prospect, problems and development of crab culture in India.

Unit-IV: Fish Feed Production

- i) Candidate species of phytoplankton and zoo-plankton as live food organisms of freshwater and marine species.
- ii) Tropic potentials- proximate composition of live feed.
- iii) Biology and culture requirements of important live food organisms. Green algae, bluegreen algae, spirulina, diatoms, infusoria, rotifers, cladocerons, tubifex, brine shrimp, chironomids.
- iv) Culture of earthworms, bait fish and forage fish.
- v) Culture of Aquatic Weed for Fish Feed Production

Unit-V: Production and Marketing of Processed Fish

- i) Fish and prawn pickles, fish sauce and Fish paste, traditional Indian fermented products. Principles and methods of preparation of various fish paste products like fish sausage, fish ham, surimi, fish cake, kamaboko etc.
- ii) Extruded products – theory of extrusion, equipments used, advantages of extruded products, methods of preparation of extruded products. Fish protein concentrate. Fish hydrolysate, partially hydrolyzed and deodorized fish meat, functional fish protein concentrate and their incorporation to various products.
- iii) Fish meal and oil. Dry reduction and wet reduction methods. Fish maws, shark leather, Chitin, chitosan, fish glue, fish gelatin, isinglass, pearl essence, shark fin rays, beach de mer, and biochemical and pharmaceutical products.

SEC-III (Theory)
**Modern Fish Culture Techniques, Pearl Culture, Biostatistics, Computer, Fishery
Legislation**

Credit: 4 Marks:50

Unit-I: Modern Fish Culture Techniques

- i) Breeding mechanism and technique with special reference to clarias.
- ii) Culture of Tilapias: Cultivated species of tilapia, Culture systems, Spawning and production of seed stock, Growout and feeding
- iii) Culture of fresh water prawn and pearl.
- iv) Aquaculture diversification- Aquaponics system, Biofloc culture, IMTA and Periphyton culture.

Unit-II: Pearl Culture

- i) Morphology and anatomy of Pearl oyster. Life cycle of pearl oyster.
- ii) Structure and Histology of mantle. Natural Process of Pearl formation. Chemical composition of Pearls.
- iii) Pearl oyster culture: Techniques of pearl oyster culture (Fresh water and Marine water) for artificial production of pearls. Pearl culture techniques -Rafts, long lines, Pearls oyster baskets, under water platforms, mother oyster culture/Collection of oysters, rearing of oysters, Environmental parameters. Pearl Oyster surgery (Selection of Oyster, Graft tissue preparation, Nucleus insertion, Conditioning for surgery), harvesting & clearing of pearl.
- iv) Diseases and Predators of Pearl oysters.
- v) Present status, Economic importance of pearls, prospects and problems of pearl industry in India.

Unit-III: Statistical Methods in Fisheries

- i) Preliminary concept, Measures of Central Tendency- Mean, Median, Mode.
- ii) Measures of variation-Range, mean deviation, standard deviation, coefficient of variation.
- iii) Correlation & Regression.
- iv) Application of statistics in Fishery

Unit-IV: Computer Application

- i) Introduction to computer, advantages, limitations, classification of computer.
- ii) Elementary idea of desktop, input-output devices-CPU, Key Board, Mouse, FD drive, CD-DVD Rom drive, RAM, Hardware and software.
- iii) Office application- software: Introduction to windows, MS Word, MS-Excel and Powerpoint Presentation.
- iv) Concept of Internet and its application
- v) Computer Database in Fishery Science

Unit-V: Fisheries Administration and Legislation

- i) Introduction to public administration, principles of organization and management of public enterprise.
- ii) Central and State responsibilities for fisheries development, organizational set up of fisheries administration at the Centre and state levels. Fishery corporations and cooperatives.
- iii) Different central and state level fisheries institutions. Role of Central and State Government in the regulatory activities of Aquaculture and fisheries.
- iv) Fisheries legislation: Overview of fisheries and aquaculture legislations in India. Indian Fisheries Act, 1897.

SEC-IV (Theory)

Fish Genetics, Molecular Biology, Biotechnology, Conservation, Remote Sensing & GIS

Credit: 4 Marks: 50

Unit-I: Fish Genetics

- i) Chromosomes- Morphology, chemical structure & kinds of chromosomal
- ii) Sex Chromosomes and sex determination, polyploidy, Sex reversal in fishes
- iii) Interaction of gene- complementary, supplementary, inhibitory (epistasis) and duplicate type.
- iv) Mutation- Gene and chromosomal
- v) Different methods of breeding- inbreeding, crossbreeding & selective breeding.

Unit-II: Basic Molecular Biology

- i) Nucleic acids: Salient features of DNA and RNA, Fine structure of Gene & Operon
- ii) Mechanism of DNA Replication: Enzymes & Factors
- iii) Protein Synthesis: Genetic code, Transcription & Translation
- iv) Principle of Genetic Engineering- Isolation of DNA and RNA, Recombinant DNA Technology, Cloning, Plasmids, Cosmids, Bacteriophages, Transformation and Transduction. Construction of genomic and cDNA library

Unit-III: Fish Biotechnology

- i) Molecular hybridization- PCR technique, Blotting techniques- Southern, Northern and Western blotting, DNA sequencing.
- ii) Chromosomal manipulation in fish: Hybridization. Polyploidy, Transgenic fishes, Androgenesis and Gynogenesis
- iii) Production of monosex and sterile fishes and their significance in aquaculture
- iv) Fish Barcoding- Concept, Method & Application

Unit-IV: Conservation of Fish Germplasm

- i) Fish Genetic Resources-Concept and its Conservation
- ii) Cryopreservation of gametes (gene banking) and its technique.
- iii) Live Gene Bank and its role in Conservation of Fish Fauna
- iv) Role of Government and Community in Conservation Initiative.

Unit-V: Remote sensing and GIS

- i) Definition and principle of remote sensing and GIS. Sensing mechanism.
- ii) Analysis of images and data. Fisheries forecasting system in India and other countries. GPS.
- iii) Application of remote sensing and GIS in fisheries conservation and management of fish faunal diversity and exploitation of capture fisheries.

DSE-I (Theory): Applied Fishery-I
Aquarium Management, Post-Harvest Technology, Fish Microbiology & Aquatic Toxicology
Credit: 4 Marks: 50

Unit-I: Aquarium Management I

- i) Aquarium- Definition and types.
- ii) Aquarium design and Construction: Design and construction of home and public aquaria (freshwater and marine)
- iii) Setting of Aquarium- gravels, plants, ornamental objects and selection of fishes.
- iv) Aquarium fishes – live bearers and egg layers.
- v) Aquarium maintenance and water quality management. Control of snail and algal growth, Temperature acclimation.
- vi) Food and feeding for aquarium fishes

Unit-II: Aquarium Management II

- i) Freshwater Ornamental Fishes & Aquarium Plants
- ii) Breeding of ornamental fishes. Selection and conditioning of fishes for breeding
- iii) Common diseases of aquarium fishes and treatment.
- iv) Culture of fish food organism with reference to Diatoms and rotifers and copepods.
- v) Indigenous ornamental fishes of North East India.

Unit-III: Post Harvest Technology

- i) Preservation- Definition, principles, merits and demerits of preservation.
- ii) Causes of spoilage of fish. Use of fish preservations and problems in fish preservation
- iii) Methods of preservation chilling, freezing, canning semidrying, salting, smoking, brining and preservation with chemicals.
- iv) Processing and preservation of fish by product – fish liver and body oil, fish meal, fish silage, fish manure, fish sauce and guano, fish guano and isinglass and fish leather.

Unit-IV: Fish Microbiology

- i) Structure of microbes: Structure of bacterial cell, Structure of fungi, Structure of virus. Classification of viruses. Life cycle bacteriophages - lytic and lysogenic cycle.
- ii) Aquatic Microbiology: Microflora of aquatic environment. Autotrophic and heterotrophic microorganisms in aquatic environment, Autochthonous and allochthonous microorganisms in aquatic environment.
- iii) Bacteria in culture pond: Health significant bacteria in culture ponds. Epidemiology of E. coli, pathogenic Vibrio, Salmonella, Aeromonas hydrophila, and Pseudomonas.

Unit-V: Aquatic Toxicology

- i) Adverse effects of oxygen demanding wastes: importance of dissolved oxygen; Oxygen demand; BOD; COD; Oxygen budget; Biological effects of organic matter.
- ii) Excessive plant nutrients: Eutrophication; Red tides and fish kills.
- iii) Pesticide types and categories; inorganic pesticides, Organo-chlorine compounds, Organo-phosphorous compounds; Polychlorinated biphenyls (PCBs);
- iv) Bioaccumulation and impact of toxins & Heavy metals in fishes
- v) Bioremediation and Phytoremediation.

DSE-I (Practical)

Credit: 2 Marks: 30

1. **On Job Training (OJT):-** Students are to participate in any training programme of atleast One Week duration conducted by any central or state government or recognized private institute within or outside the state concerning fisheries/ post-harvest technology/ fresh water fish farm/ prawn or shrimp farm or any other fisheries institute. They have to submit a detailed report of their training programme, along with photographs, certificate etc & duly authenticated by teacher- in charge.
2. **Identification of Ornamental Fishes and Aquatic/Aquarium Plants**
3. **Identification of Microbes associated with Fish**
4. **Demonstration of Post Harvest technology using visual Aids**
5. **Laboratory Note Book**
6. **Viva Voce**

Distribution of Marks:

i)	OJTR	10
ii)	Identification of Ornamental Fish, Plant & Microbe (3x2)	6
iii)	Visual Display	5
iv)	Regularity	5
v)	Laboratory notebook-	2
vi)	Viva Voce-	2

Total 30

DSE-II (Theory): Applied Fishery-II
Fishery Economics, Fish Marketing, Fishery Extension & Co-operatives, Financing in Fishery, Disaster Management
Credit: 4 Marks:50

Unit-I: Fishery Economics

- i) Principles of economics: Definition, Law of diminishing returns, laws of increasing, constant and decreasing utility and returns.
- ii) Importance of economics in aquaculture development.
- iii) Economic value of fishes,
- iv) Maximum Sustainable Yield (MSY), Maximum Economic Yield (MEY), Optimum Sustainable Yield (OSY)
- v) Overfishing, Aquaranching (Culture based capture method)
- vi) Economy of fishermen: Fishermen populations, GDP from fisheries sector, foreign exchange earnings and employment potential of fishing industry.

Unit-II: Fish Marketing

- i) Fish marketing- definition, Aim, Characteristic, Types and Stages of fish marketing.
- ii) Marketing channels and supply chain, Marketing margins, Marketing environment, Marketing strategies, Consumer behaviour
- iii) Fish markets and marketing in India, Problems of fish marketing in India.
- iv) Cold storage and other marketing infrastructure in India.
- v) Methods of selling fish, Price Determination marketing organization and improvement.
- vi) Exports of fish and fishery products, trends and problems therein. Role of MPEDA in exports of fish and fishery products.

Unit-III: Fishery Extension & Co-operatives

- i) Fishery co-operative- Aim and role of co-operative in fishery economy. Organization of fishermen co-operatives.
- ii) Fisheries extension- Definition, extension philosophy and Methodology
- iii) Fishing community and their socio- economic problems.
- iv) Fish farmers development Agencies (FFDA)
- v) Rational fishery- introduction, organization

Unit-IV: Scopes & Financing in Fishery Management

- i) Study, Training & Research opportunities in Fisheries in India with special reference to NER
- ii) Credit Requirements & Role of credit for fisheries
- iii) Schemes of National Fishery Development Board (NFDB) & NABARD
- iv) Role of District Fishery Development Office.
- v) Role of insurance in Fish Farming Industry.

Unit-V: Disaster Management in Fisheries

- i) Basic concepts: Hazard, risk, vulnerability, disaster, capacity building
- ii) Types of natural and manmade hazards in fisheries and aquaculture - cyclones, floods, droughts, tsunami, El-nino, habitat destruction, over fishing, introduction of exotic species
- iii) Management strategies: pre-disaster, during disaster and post-disaster, early warning, communication and dissemination, community based disaster preparedness, structural and non-structural mitigation measures.

DSE-II (Practical)

Credit: 2 Marks: 30

1. **Survey of local Fish Markets** and Preparation of Project Report on Demand and Supply, Supply Chain, Marketing Management, Pricing of various Fishes, Transportation and Storage of Fishes, other Market Strategies, Consumer Behaviour etc.
2. **Organizing lectures/Interaction Programmes/Students' Exposure Programme on Study & Training Opportunities/Financing in Fisheries/Disaster Management & Fisheries** by engaging people from District and State Fisheries Development Offices/ NABARD/ Bank Officers/ NFDB/ Established Fishermen Community/ any other related person.

A Report on the various Govt. Schemes, and Bank Loans, Procedure for Applying for Loans or other related topic is to be submitted based on the Lectures/Interaction

3. **Submission** – students are to submit at least five wet preserved specimens mentioning name, classification etc. during practical examination
4. **Viva voce**

Distribution of Marks:

i)	Survey Report	10
ii)	Report Submission	8
iii)	Submission	5
iv)	Regularity	5
v)	Viva Voce-	2

Total 30