West Bengal State University

SYLLABUS FOR

FISHERY SCIENCE (Major)

UNDER

CURRICULUM AND CREDIT FRAME WORK

FOR

UNDERGRADUATE PROGRAM

(With effect from the session 2023-2024)

SEMESTER WISE AND COURSE CATEGORY WISE DISTRIBUTION OF CREDITS

Semester	Major (DSC)	Minor	MDC	AEC	SEC	VAC	Internship	Total Credits
I	DS-1 (5)	MA-1 (5) MB-1 (5)	MD-1 (3)	AE-1 (3)	SE-1 (3)	VA-1 (3)		27
II	DS-2 (5)	MA-2 (5) MB-2 (5)	MD-2 (3)	AE-2 (3)	SE-2 (3)	VA-2 (3)	4**	27
Exit with Certificate								4**+ 54
III	DS-3 (5)	MA-3 (5) MB-3 (5)	MD-3 (3)	AE-3 (3)	SE-3 (3)			24
IV	DS-4 (5) DS-5 (5) DS-6 (5) DS-7 (5)						4**	20
Exit with Diploma								4**+98
V	DS-8 (5) DS-9 (5) DS-10 (5) DS-11 (5)							20
VI	DS-12 (5) DS-13 (5) DS-14 (5) DS-15 (5)						4**	20
Exit with Major								4**+138
VII	DS-16 (5) DS-17 (5)	SM-1 (5) SM-2 (5)						20
VIII	DS-18 (5) DS-19 (5) DS-20 (5) DS-21 (5)						15**	20
Honors								182
Honors with Research								187

*** Students who want to exit with certificate after II semester will have to complete an internship of 4 credits in II semester; who want to exit with diploma after IV semester will have to complete an internship of 4 credits in IV semester and who want to exit with Major after VI semester will have to complete an internship of 4 credits in VI semester.**

Students who will opt for Honors with Research will study two DSCs (Credits 5 each) in VIII semester along with 15 credits of Research Project/Dissertation.

SEMESTER AND COURSE WISE DISTRIBUTION OF CREDITS

Semester	Course Name	Course Detail	Credits
I	Discipline Specific Course 1 (DS-1)	Taxonomy and General Characteristics of Fishes (DS-1)	3
	Discipline Specific Course 1 (DS-1-P)	Taxonomy and General Characteristics of Fishes (Lab) (DS-1-P)	2
	Minor Discipline 1 (MA-1)		3
	Minor Discipline 1 (MA-1-P)		2
	Minor Discipline 2 (MB-1)		3
	Minor Discipline 2 (MB-1-P)		2
	Multi Disciplinary Course 1 (MD-1)		3
	Ability Enhancement Course (AE-1)		3
	Skill Enhancement Course 1 (SE-1)	Aquarium Management (SE-1)	3
	Value Added Course (VA-1)		3
II	Discipline Specific Course 2 (DS-2)	Biology of Fishes (DS-2)	3
	Discipline Specific Course 2 (DS-2-P)	Biology of Fishes (Lab) (DS-2-P)	2
	Minor Discipline 3 (MA-2)		3
	Minor Discipline 3 (MA-2-P)		2
	Minor Discipline 4 (MB-2)		3
	Minor Discipline 4 (MB-2-P)		2
	Multi Disciplinary Course 2 (MD-2)		3
	Ability Enhancement Course 2 (AE-2)		3
	Skill Enhancement Course 2 (SE-2)	Fish Feed Preparation and Quality Control (SE-2)	3
	Value Added Course 2 (VA-2)		3
	Internship (**Exit with Certificate**)		4
III	Discipline Specific Course 3 (DS-3)	Freshwater Aquaculture (DS-3)	3
	Discipline Specific Course 3 (DS-3-P)	Freshwater Aquaculture (Lab) (DS-3-P)	2
	Minor Discipline 5 (MA-3)		3
	Minor Discipline 5 (MA-3-P)		2
	Minor Discipline 6 (MB-3)		3
	Minor Discipline 6 (MB-3-P)		2
	Multi Disciplinary Course 3 (MD-3)		3
	Ability Enhancement Course 3 (AE-3)		3
	Skill Enhancement Course 3 (SE-3)	Aquaculture and Aquatic Ecology (SE-3)	3
IV	Discipline Specific Course 4 (DS-4)	Ornamental Fish Culture (DS-4)	3
	Discipline Specific Course 4 (DS-4-P)	Ornamental Fish Culture (Lab) (DS-4-P)	2
	Discipline Specific Course 5 (DS-5)	Post Harvest Technology (DS-5)	3
	Discipline Specific Course 5 (DS-5-P)	Post Harvest Technology (Lab) (DS-5-P)	2
	Discipline Specific Course 6 (DS-6)	Value Added Fish Products (DS-6)	3
	Discipline Specific Course 6 (DS-6-P)	Value Added Fish Products (Lab) (DS-6-P)	2
	Discipline Specific Course 7 (DS-7)	Hatchery Technology (DS-7)	3
	Discipline Specific Course 7 (DS-7-P)	Hatchery Technology (Lab) (DS-7-P)	2
	Internship (**Exit with Diploma**)		4
V	Discipline Specific Course 8 (DS-8)	Freshwater Ecology (DS-8)	3
	Discipline Specific Course 8 (DS-8-P)	Freshwater Ecology (Lab) (DS-8-P)	2
	Discipline Specific Course 9 (DS-9)	Inland and Marine Fishery (DS-9)	3

	Discipline Specific Course 9 (DS-9-P)	Inland and Marine Fishery (Lab) (DS-9-P)	2
	Discipline Specific Course 10 (DS-10)	Coastal Aquaculture and Mariculture (DS-10)	3
	Discipline Specific Course 10 (DS-10-P)	Coastal Aquaculture and Mariculture (Lab) (DS-10-P)	2
	Discipline Specific Course 11 (DS-11)	Fishing Craft and Gear Technology (DS-11)	3
	Discipline Specific Course 11 (DS-11-P)	Fishing Craft and Gear Technology (Lab) (DS-11-P)	2
VI	Discipline Specific Course 12 (DS-12)	Fish Pathology and Immunology (DS-12)	3
	Discipline Specific Course 12 (DS-12-P)	Fish Pathology and Immunology (Lab) (DS-12-P)	2
	Discipline Specific Course 13 (DS-13)	Aquaculture Nutrition (DS-13)	3
	Discipline Specific Course 13 (DS-13-P)	Aquaculture Nutrition (Lab) (DS-13-P)	2
	Discipline Specific Course 14 (DS-14)	Larval Diet and Live Fish Food Organisms (DS-14)	3
	Discipline Specific Course 14 (DS-14-P)	Larval Diet and Live Fish Food Organisms (Lab) (DS-14-P)	2
	Discipline Specific Course 15 (DS-15)	Biostatistics and Computer Application (DS-15)	3
	Discipline Specific Course 15 (DS-15-P)	Biostatistics and Computer Application (Lab) (DS-15-P)	2
	Internship (**Exit with Major**)		4
VII	Discipline Specific Course 16 (DS-16)	Entrepreneurship Development (DS-16)	3
	Discipline Specific Course 16 (DS-16-P)	On-job Training (DS-16-P)	2
	Discipline Specific Course 17 (DS-17)	Fisheries Economics (DS-17)	3
	Discipline Specific Course 17 (DS-17-P)	Market Survey (DS-17-P)	2
	Special Minor Course 1 (SM-1)		3
	Special Minor Course 1 (SM-1-P)		2
	Special Minor Course 1 (SM-2)		3
	Special Minor Course 1 (SM-2-P)		2
VIII	Discipline Specific Course 18 (DS-18)	Fish Microbiology (DS-18)	3
	Discipline Specific Course 18 (DS-18-P)	Fish Microbiology (Lab) (DS-18-P)	2
	Discipline Specific Course 19 (DS-19)	Fish Genetics and Biotechnology (DS-19)	3
	Discipline Specific Course 19 (DS-19-P)	Fish Genetics and Biotechnology (Lab) (DS-19-P)	2
	Discipline Specific Course 20 (DS-20)	Biochemistry and Quality Assurance (DS-20)	3
	Discipline Specific Course 20 (DS-20-P)	Biochemistry and Quality Assurance (Lab) (DS-20-P)	2
	Discipline Specific Course 21 (DS-21)	Tools and Techniques (DS-21)	3
	Discipline Specific Course 21 (DS-21-P)	Tools and Techniques (Lab) (DS-21-P)	2
	Research Project/Dissertation (**Honors with Research**)		**15**

Students who will opt for Honors with Research will study two DSCs (Credits 5 each) in VIII semester along with 15 credits of Research Project/Dissertation

SEMESTER WISE DISCIPLINE SPECIFIC COURSE TYPE

Semester	Course Type	Course Name	Credits
I	FSCDSC101	Taxonomy and General Characteristics of Fishes+ Lab	3+2
II	FSCDSC201	Biology of Fishes + Lab	3+2
III	FSCDSC301	Freshwater Aquaculture + Lab	3+2
IV	FSCDSC401	Ornamental Fish Culture + Lab	3+2
	FSCDSC402	Post Harvest Technology + Lab	3+2
	FSCDSC403	Value Added Fish Products + Lab	3+2
	FSCDSC404	Hatchery Technology + Lab	3+2
V	FSCDSC501	Freshwater Ecology + Lab	3+2
	FSCDSC502	Inland and Marine Fishery + Lab	3+2
	FSCDSC503	Coastal Aquaculture and Mariculture + Lab	3+2
	FSCDSC504	Fishing Craft and Gear Technology + Lab	3+2
VI	FSCDSC601	Fish Pathology and Immunology + Lab	3+2
	FSCDSC602	Aquaculture Nutrition + Lab	3+2
	FSCDSC603	Larval Diet and Live Fish Food Organisms + Lab	3+2
	FSCDSC604	Biostatistics and Computer Application + Lab	3+2
VII	FSCDSC701	Entrepreneurship Development + On-job Training Fish	3+2
	FSCDSC702	Fisheries Economics + Market Survey	3+2
VIII	FSCDSC801	Fish Microbiology + Lab	3+2
	FSCDSC802	Genetics and Biotechnology + Lab	3+2
	FSCDSC803	Biochemistry and Quality Assurance + Lab	3+2
	FSCDSC804	Tools and Techniques + Lab	3+2

SEMESTER I

DISCIPLINE SPECIFIC COURSE (FSCDSC101T)	TAXONOMY AND GENERAL CHARACTERISTICS OF FINFISHES AND SHELLFISHES	
CREDIT 3	**CLASS 45 HOURS**	**MARKS 50**

Module 1: Introduction to Taxonomy

Importance of taxonomy; Types of classification - phenetic, natural, cladistics and evolutionary classification; Zoological Nomenclature - International Code of Zoological Nomenclature; Typification - Allotype, Holotype, Lectotype, Paratype and Syntype.

Module 2: Taxonomy of Fish

Basic methods used in taxonomic studies - morphometric, meristic and descriptive characteristics; General characteristics of elasmobranchs and teleosts with examples.

Module 3: Taxonomy of Crustacea

External features used for taxonomic identification of *Macrobrachium rosenbergii*, *Penaeus monodon* and *Scylla serrata*.

Module 4: Taxonomy of Mollusca

General features of gastropods, bivalves and cephalopods; Taxonomic features of mussels, oyster, clams and scallops.

Module 5: Specialized Organs

Adaptations for swimming, body forms, fins; Structure and function of skin and mucous layer; Different types of scales; Sense organs in fishes - organs of smell, taste buds, lateral line system, Ampullae of Lorenzini; Specialized organs in fishes - electric organs, weberian ossicles and poison gland.

Module 6: Fish behavior and Special Phenomenon

Parental care in fish; Migration in fishes and orientation; Fish coloration; Bioluminescence in fish; Diurnal, lunar, circadian and tidal rhythm.

REFERENCES

1. Simpson GG. 2012. Principles of Animal Taxonomy. Scientific Publishers India.
2. Mayr E. 1991. Principles of Systematic Zoology. McGraw-Hill Inc.,U.S.
3. Kapoor VC. 2019. Theory and practice of animal taxonomy and biodiversity, Oxford & IBH Publishing.
4. Jayaram KC. 2009. Fundamentals of Fish Taxonomy. Narendra Publishing House, New Delhi.
5. Talwar PK and Jhingran AG. 1991. Inland fishes of India and adjacent countries. Vol-1 and Vol-2. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, Bombay and Calcutta.
6. Nelson JS, Grande TC and Wilson MVH. 2016. Fishes of the World. Wiley.
7. Ruppert EE and Barnes RD. 1994. Invertebrate Zoology. Saunders College Pub.
8. Ganguly BA, Sinha AK, Adhikari S and Goswami BCB. 2018. Biology of Animals (Vol I and II). NCBA
9. Khanna SS and Singh HR. 2014. A Textbook of Fish Biology and Fisheries. Narendra Publishing House, New Delhi
10. Gupta SK and Gupta PC. 2006. General and Applied Ichthyology: Fish and Fisheries. S Chand & Company

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC101P)	TAXONOMY AND GENERAL CHARACTERISTICS OF FINFISHES AND SHELLFISHES (LAB)	
CREDIT 2	**CLASS 60 HOURS**	**MARKS 50**

1. Identification of some important fish species (*Scoliodon* sp., *Dasyatis* sp., *Labeo rohita*, *Cirrhinus mrigala*, *Gibelion catla*, *Clarias magur*, *Heteropneustes fossilis*, *Puntius sophore*; *Anabas testudineus, Tenualosa ilisha, Chitala chitala* and *Cyprinus carpio*).
2. Identification of shellfish (*Macrobrachium rosenbergii*, *Scylla serrata* and *Lamellidense marginalis*).
3. Morphometric and meristic study of *Labeo* sp. and Tilapia.

COURSE OUTCOME

TAXONOMY AND GENERAL CHARACTERISTICS OF FINFISHES AND SHELLFISHES (FSCDSC101T)

Students will be able to gather in-depth knowledge on basics of taxonomy; taxonomy of fish and methods of fish identification; taxonomy of crustacea and mollusca; specialized sense organs of fishes like taste buds, olfactory system, Ampulla of Lorenzini, lateral line system; specialized organs of fishes like electric organ, weberian ossicles and poison gland; phenomenon of bioluminescence; fish coloration; parental care; migration and mechanism of buoyancy control in fish.
TAXONOMY AND GENERAL CHARACTERISTICS OF FINFISHES AND SHELLFISHES (FSCDSC101P)
Students will have the practical exposure on taxonomic identification of commercially important finfishes and shellfishes and morphometric and meristic study technique of fishes.

MINOR COURSE (MA-1)			
MA-1	**CREDIT 3**	**CLASS 45**	**MARKS 50**
MA-1-P	**CREDIT 2**	**CLASS 60**	**MARKS 50**

MINOR COURSE (MB-1)			
MB-1	**CREDIT 3**	**CLASS 45**	**MARKS 50**
MB-1-P	**CREDIT 2**	**CLASS 60**	**MARKS 50**

MULTI DISCIPLINARY COURSE (MD-1)			
MD-1	**CREDIT 3**	**CLASS 45**	**MARKS 50**

ABILITY ENHANCEMENT COURSE (AEC-1)			
AEC-1	**CREDIT 3**	**CLASS 45 HOURS**	**MARKS 50**

SKILL ENHANCEMENT COURSE (FSCHSE101M)		**AQUARIUM MANAGEMENT**
CREDIT 3	**CLASS 45 HOURS**	**MARKS 50**
Basic concept of aquarium; Types of aquarium; Design and construction of all glass aquarium; Aquarium accessories: aerator, pump, filter, decor, thermostat, thermometer, feeding equipments; Setting up of aquarium: Selection of substrate and fish species, species combination; Water quality management and maintenance; Different varieties of ornamental fishes; Common aquarium plants; Different types of aquarium fish feed; Common ornamental fish disease and their treatment		
COURSE OUTCOME		
AQUARIUM MANAGEMENT (FSCHSE101M)		
Students will acquire in depth knowledge on different types of aquarium; the technique to construct all glass aquarium; working principles and use of different aquarium accessories; setting up of aquarium; management of water quality parameter of an aquarium; different varieties of ornamental fishes and aquarium plants; different types of fish feed in use; types of common ornamental fish diseases and their treatment measures.		

VALUE ADDED COURSE (VA-1)			
VA-1	**CREDIT 3**	**CLASS 45 HOURS**	**MARKS 50**

SEMESTER II

DISCIPLINE SPECIFIC COURSE (FSCDSC201T)	BIOLOGY OF FISHES	
CREDIT 3	**CLASS 45 HOURS**	**MARKS 60**
Module 1: Feeding Biology Food and Feeding habit of fish- herbivores, carnivores and omnivores; Macrophagous, microphagous, benthophagous and planktivore feeding adaptations; General morphology of alimentary system of herbivorous, carnivorous and omnivorous fishes; Process of digestion in fish.		
Module 2: Study of Fish Growth Fish growth - absolute and relative growth, isometric and allometric growth; Analysis of growth checks on hard parts (scales and otolith); Marking and tagging of fish for growth studies.		
Module 3: Reproductive Biology Reproductive system of fish and prawn (structure of ovary and testis; gonadal maturity stages); Reproduction in fish - spawning behavior; factors affecting spawning in fish, oviparous, viviparous and ovo-viviparous fishes, types of eggs; Sexual dimorphism in fishes.		
Module 4: Respiration and Circulation Respiratory system- General description of respiratory organs in fish (type – shark and *Labeo* sp.); Aquatic respiration, respiratory gases and gaseous exchanges; Adaptation of air breathing fishes; Respiration in prawns. Cardiovascular system - General features of heart in fish, crustacean and Mollusca; blood circulatory system and oxygen transport in fishes.		
Module 5: Excretion Structure of teleostean kidney; Osmoregulation in freshwater teleosts, marine teleosts and elasmobranches.		
REFERENCES		
1. Khanna SS and Singh HR. 2014. A Textbook of Fish Biology and Fisheries. Narendra Publishing House, New Delhi 2. Gupta SK and Gupta PC. 2006. General and Applied Ichthyology: Fish and Fisheries. S Chand & Company 3. Srivastava CBL. 2008. Fish Biology. Narendra Publishing House, New Delhi. 4. Bone Q and Moore R. 2008. Biology of Fishes. Taylor and Francis. 5. Pandey K and Shukla JP. 2018. Fish and Fisheries. Rastogi Publications.		

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC201P)	BIOLOGY OF FISHES (LAB)	
CREDIT 2	**CLASS 60 HOURS**	**MARKS 50**
1. Dissection - Alimentary system of fish (Tilapia and *Mystus* sp.) 2. Dissection - Reproductive system of fish (Tilapia and *Mystus* sp.) 3. Fecundity estimation in fish (Tilapia and *Mystus* sp.) 4. Estimation of Gonado Somatic Index (GSI) in fish (Tilapia and *Mystus* sp.) 5. Gut content analysis of finfish (*Labeo* sp.) 6. Identification of scale types (Cycloid, Ctenoid and Placoid) 7. Collection of otolith (Tilapia)		

COURSE OUTCOME
BIOLOGY OF FISHES (FSCDSC201T)
Students will gather knowledge on different feeding habit of fishes and morphological difference related to feeding habit; types and analysis of fish growth; fish physiology in relation to respiration, circulation, excretion and osmoregulation and reproductive biology of fishes and associated factors related to reproduction.

BIOLOGY OF FISHES (FSCDSC201P)
Students will be able to dissect out the alimentary canal and reproductive system of fish; estimate the fecundity and gonado-somatic index of fish; analyze the gut content of fish to study the feeding habit; identify the different scale types of fish and collection of otolith for age determination.

MINOR COURSE (MA-2)			
MA-2	CREDIT 3	CLASS 45	MARKS 50
MA-2-P	CREDIT 2	CLASS 60	MARKS 50

MINOR COURSE (MB-2)			
MB-2	CREDIT 3	CLASS 45	MARKS 50
MB-2-P	CREDIT 2	CLASS 60	MARKS 50

MULTI DISCIPLINARY COURSE (MD-2)			
MD-2	CREDIT 3	CLASS 45	MARKS 50

ABILITY ENHANCEMENT COURSE (AEC-2)			
AEC-2	CREDIT 3	CLASS 45 HOURS	MARKS 50

SKILL ENHANCEMENT COURSE (FSCHSE202M)	FISH FEED PREPARATION AND QUALITY CONTROL

CREDIT 3	CLASS 45 HOURS	MARKS 50
Nutritional requirement of cultivable fish and shell fish; Feed additives: Growth promoter, immunostimulant, Prebiotics, Probiotics, Food colorant, Chemoattractant, Antioxidants, Binders, Enzymes; Feed formulation and manufacturing. Types of feed: Dry (pellet, flakes, crumbles, powder) and moist feed; Feed storage; Storage problems and remedial measures. Feed Evaluation: Feed Conversion Ratio, Feed Conversion Efficiency; Protein Efficiency Ratio. Feeding devices: Demand feeder (bag method and check tray) and automatic feeder.		

COURSE OUTCOME
FISH FEED PREPARATION AND QUALITY CONTROL (FSCHSE202M)
Students will gather knowledge on nutritional requirement of fin fishes and shell fishes common in aquaculture; different types of feed additives; feed formulation and preparation techniques; different types of feed; storage methods and storage problems and their solution; important properties for quality evaluation of fish feed and feeding methods.

VALUE ADDED COURSE (VA-2)			
VA-2	CREDIT 3	CLASS 45 HOURS	MARKS 50

INTERNSHIP (FSCHINT02P)	
CREDIT 4	MARKS 50 (Project Report: 30; Viva-Voce: 20)

SEMESTER III

DISCIPLINE SPECIFIC COURSE (FSCDSC301T)	FRESHWATER AQUACULTURE

CREDIT 3	CLASS 45 HOURS	MARKS 50

Module 1: Carp Culture

Various freshwater organisms used for aquaculture in India; Pre-stocking (different methods for the eradication of weed fishes, predators, aquatic insects and aquatic weeds, liming and fertilization), stocking and post stocking management of nursery, rearing and grow-out pond for carp culture; Composite fish culture.

Module 2: Culture of Catfishes and Murrels

Culturable species, Spawning and fry production and grow out.

Module 3: Cold Water Aquaculture

Culture of Trout and Mahseer- Culture systems, development of brood stock, techniques of propagation.

Module 4: Systems of Aquaculture

Criteria for the selection of site and species for fresh water aquaculture; Fish culture in ponds, cages, pens, raceways and indoor tanks; Monoculture and polyculture; Sewage fed fish culture; Integrated fish farming (Rice cum fish culture, Duck cum fish culture, Poultry cum fish culture and Pig cum fish culture); Bio-floc culture.

Module 5: Culture of Prawn and Molluscs

Cultivable species of freshwater prawn; Life cycle and culture of *Macrobrachium rosenbergii*; Fresh water pearl culture.

REFERENCES

1. Pillay TVR and Kutty MN. 2011. Aquaculture: Principles and Management. Willey India Pvt. Ltd
2. Bardach JE, Rhyther JH and Mc. Larney WO. 1974. Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms. John Wiley & Sons
3. Landau M. 1991. Introduction to Aquaculture. Wiley.
4. Rath RK. 2011. Freshwater Aquaculture. Scientific Publishers (India)
5. Santhanam R, Sukumaran N and Natarajan P. 1987. A Manual of Freshwater Aquaculture. South Asia Books
6. Jhingran VG. 1997. Fish and Fisheries of India. Hindustan Publishing Corporation.
7. Jhingran VG and Sehgal KL. 1978. Coldwater Fisheries of India. Inland Fisheries Society of India, Barrackpore.
8. Bardach JE, Ryther JH and McLarney WO. 1974. Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms. John Willy & Sons Ltd.
9. Huet M. 1994. Textbook of Fish Culture. Wiley.
10. Pullin RSV and Shehadeh ZH. 1980. Integrated Agriculture-Aquaculture Farming Systems. ICLARM
11. Badapanda KC. 2013. Basics of Fishery Science. Narendra Publishing House, New Delhi.
12. Chakraborty C and Sadhu AK. 2000. Biology, Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn. Daya Publishing House.

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC301P)	FRESHWATER AQUACULTURE (LAB)

CREDIT 2	CLASS 60 HOURS	MARKS 50

1. Identification of fry and fingerling stages of Indian Major Carp
2. Identification of important aquatic weeds (*Eichhornia*, *Pistia*, *Lemna*, *Hydrilla*, *Nelumbo*)
3. Identification of aquatic insects (*Ranatra*, *Nepa*, *Anisops*)
4. Identification of larval stages of crustaceans and molluscs (Nauplius, Mysis, Zoea, Megalopa, Glochidium, Trochophore)
5. Educational visit to a sewage fed fish culture/ integrated fish culture farm and report submission

COURSE OUTCOME
FRESHWATER AQUACULTURE (FSCDSC301T)
Students will gather knowledge on culture methods of Indian Major Carps; required steps for pre-stocking, stocking and post-stocking management; culture of air-breathing and coldwater fishes; different types of culture techniques like cage, pen, raceway, sewage fed and integrated fish culture; culture of freshwater prawn and fresh water mussel for pearl culture.
FRESHWATER AQUACULTURE (FSCDSC301P)
Students will have the practical exposure on identification of fry and fingerlings of Indian Major Carps; identification of common aquatic weeds and aquatic insects; identification of larval stages of crustacea and mollusca and an overall idea on sewage fed/ integrated fish culture during the educational visit.

MINOR COURSE (MA-3)			
MA-3	**CREDIT 3**	**CLASS 45**	**MARKS 50**
MA-3-P	**CREDIT 2**	**CLASS 60**	**MARKS 50**

MINOR COURSE (MB-3)			
MB-3	**CREDIT 3**	**CLASS 45**	**MARKS 50**
MB-3-P	**CREDIT 2**	**CLASS 60**	**MARKS 50**

MULTI DISCIPLINARY COURSE (MD-3)			
MD-3	**CREDIT 3**	**CLASS 45**	**MARKS 50**

ABILITY ENHANCEMENT COURSE (AEC-3)			
AEC-3	**CREDIT 3**	**CLASS 45 HOURS**	**MARKS 50**

SKILL ENHANCEMENT COURSE (FSCHSE303M)	**AQUACULTURE AND AQUATIC ECOLOGY**	
CREDIT 3	**CLASS 45 HOURS**	**MARKS 50**
Pond construction; Pre-stocking (different methods for the eradication of weed fishes, predators, aquatic insects and aquatic weeds, liming and fertilization), stocking and post stocking management of nursery, rearing and grow-out pond for carp culture; Hypophysation of fish – collection of pituitary gland, preparation and preservation of pituitary extract, dosages and methods of injection. Working of an ecosystem – Food chain, food web and energy flow; Bioconcentration, biomagnification, eutrophication; Aquatic pollution. Management of water quality parameters		

COURSE OUTCOME
AQUACULTURE AND AQUATIC ECOLOGY (FSCHSE303M)
Students will gather knowledge on pond construction; strategies of management of nursery, rearing and grow-out pond; techniques of induced breeding of IMCs; basic concepts on aquatic ecology and management of hydrological parameters of an aquatic habitat.

SEMESTER IV

DISCIPLINE SPECIFIC COURSE (FSCDSC401T)	ORNAMENTAL FISH CULTURE	
CREDIT 3	**CLASS 45 HOURS**	**MARKS 50**
Module 1: Aquarium Design and Construction Introduction to aquarium; Design and construction of home and public aquaria (freshwater); Aquarium accessories - aerators, filters, decors, thermostat and thermometer, feeding equipments and light.		
Module 2: Aquarium Management Setting up of aquarium, selection of fishes, temperature acclimation and quarantine measures; Aquarium maintenance and water quality management for fresh water aquarium; Handling, care, quarantine, packing and transportation of fishes - Use of anesthetics.		
Module 3: Freshwater Ornamental Fishes Species of ornamental fishes - their taxonomy and biology - live bearers (molly and guppy), gold fish, gourami, fighter fish, barbs, tetras and angel fish; Indigenous ornamental fishes of West Bengal; Maturation, secondary sexual characters, breeding habits, spawning, parental care.		
Module 4: Marine Ornamental Fishes Marine ornamental fishes - varieties and their habitat; Major marine ornamental fish resources of India; Reef aquarium and live rocks.		
Module 5: Commercial Production Commercial production of goldfish, live bearers, gouramies, barbs and tetras and angel fish; Breeding of marine ornamental fishes (clown fishes and Damsel fishes); Propagation of aquarium plants - different methods; Trade regulations and wild life act in relation to ornamental fishes.		
REFERENCES		
1. Alappat HJ and Biju Kumar A. 1996. A Complete Guide to Aquarium Keeping. Books for All, New Delhi. 2. Axelrod HR, Burgess WE, Pronek L and Walls JG. 1997. Atlas of Freshwater Aquarium Fishes. TFH Publications. 3. Dholakia AD. 2020. Ornamental Fish Culture and Aquarium Management. Daya Publishing House. 4. Kurup MB. 2008. Ornamental Fish Farming, Breeding and Trade. Department of. Fisheries, Government of Kerala. 5. Tekriwal K. 1999. Ornamental Aquarium Fish of India. Kingdom Books. 6. Santhanam R, Sukumaran N and Natarajan P. 1987. A Manual of Freshwater Aquaculture. South Asia Books		

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC401P)	ORNAMENTAL FISH CULTURE (LAB)	
CREDIT 2	**CLASS 60 HOURS**	**MARKS 50**
1. Identification of common ornamental fishes (goldfish, angel, tiger barb, sword tail, fighter fish, oscar, dwarf gourami, Indian glass fish, Y- loach, rosy barb) 2. Identification of common aquarium plants (*Vallisneria*, *Cabomba*, *Echinodorus* and *Anubias*) 3. Identification and use of aquarium accessories (pump, diffuser, air-flow controller, under-gravel filter, corner filter, internal power filter, thermostat, feeding cone) 4. Setting up of a freshwater aquarium 5. Educational visit to an ornamental fish farm/market and report submission		

COURSE OUTCOME
ORNAMENTAL FISH CULTURE (FSCDSC401T)
Students will be able to gather knowledge on design and construction of aquarium; different types of essential aquarium accessories; steps to be followed for setting up of aquarium; maintenance of aquarium and management of water quality parameters; handling, care, packing and transportation of ornamental fishes; different types of freshwater ornamental fishes, their breeding, parental care, larval

rearing; types of aquarium plants and their propagation methods; indigenous ornamental fishes of West Bengal; varieties of marine ornamental fishes; reef aquarium and live rock and culture of some common freshwater and marine ornamental fishes.

ORNAMENTAL FISH CULTURE (FSCDSC401P)

Students will be able to identify common freshwater exotic and indigenous ornamental fishes and common aquarium plants; know the working principle of important aquarium accessories like aerators, filters, thermostat, feeding equipment etc. and setting up of an aquarium. The educational excursion will help them to know the varieties of ornamental fishes available in the market/the overall management procedure of an ornamental fish farm.

DISCIPLINE SPECIFIC COURSE (FSCDSC402T)	POST HARVEST TECHNOLOGY	
CREDIT 3	**CLASS 45 HOURS**	**MARKS 50**

Module 1:Seafood Spoilage

Principles and importance of fish preservation; Fish spoilage- post mortem changes (rancidity and rigor mortis); Importance of hygiene and sanitation in fish handling; Quality of water and ice in fish handling and processing.

Module 2: Chilling and Freezing

Fundamental principles involved in chilling and freezing of fish and fishery products; Icing - Different types of ice used in the seafood industry and their merits; Methods of freezing; Changes that occur during frozen storage - microbiological, physical and chemical changes, protein denaturation, fat oxidation, dehydration, drip.

Module 3: Common Post-harvest Techniques

Principle of drying; Different types of drying; Spoilage of dried products; Theory of salting, methods of salting - wet salting and dry salting; Spoilage of salted product; Principle of smoking; Different types of smoking: Cold and hot smoking; Spoilage of smoked products; Principle of fermentations: fermented products; Principles and processes involved in canning of fish; Spoilage of canned foods.

Module 4: Non-thermal Food Processing Techniques, Storage and Packaging

Principles and advantages of high pressure processing; Ultrasound food processing; Pulsed electric filed processing; Pulsed light technology; Microwave processing; Irradiation. Functions of packing; Different types of packing materials.

REFERENCES

1. Balachandran KK. 2002. Postharvest Technology in Fish and Fishery Products. Daya Publishing House.
2. Gopakumar K. 2006. Textbook of Fish Processing Technology. Indian Council of Agricultural Research.
3. Govindan TK. 1987. Fish Processing Technology. Oxford and IBH Publication Co.
4. Hall GM. 1992. Fish Processing Technology. Blackie
5. Sen DP. 2005. Advances in Fish Processing Technology. Allied Publishers Pvt. Ltd.
6. Biswas KP. 2020. Fish Processing and Preservation. Daya Publishing House.
7. Badapanda KC. 2013. Fish Processing and Preservation Technology. Narendra Publishing House.
8. Moorjani MV. 1984. Fish Processing in India. Indian Council of Agricultural Research.
9. Gopakumar K. 1993. Fish Packaging Technology: Materials and Methods. Concept Publishing Co.

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC402P)	POST HARVEST TECHNOLOGY (LAB)	
CREDIT 2	**CLASS 60 HOURS**	**MARKS 50**

1. Calculation of ice for chilling fishes
2. Filleting of fish
3. Organoleptic analysis of fresh and spoiled fish
4. Principles of freezing, chilling, drying and canning

COURSE OUTCOME
POST HARVEST TECHNOLOGY (FSCDSC402T)
Students will be able to know about spoilage of fish food and its preventive measures; different types of ice and their merits; importance of hygiene and sanitation in fish handling; common seafood preservation techniques like smoking, drying, fermentation, chilling, freezing, thermal processing, canning; different non-thermal food processing techniques and different types of packaging materials.
POST HARVEST TECHNOLOGY (FSCDSC402P)
Students will be able to calculate the amount of ice required for chilling of fishes; know the technique of filleting of fish; know the basics of organoleptic analysis of fresh and spoiled fish as well as principles of freezing, chilling, drying and canning.

DISCIPLINE SPECIFIC COURSE (FSCDSC403T)	**VALUE ADDED FISH PRODUCTS**	
CREDIT 3	**CLASS 45 HOURS**	**MARKS 50**
Module 1: Introduction Value addition in sea food; Different types of value added products from fish and shell fishes; Advantages of value addition; Prospects of value added products and its future in Indian market.		
Module 2: Mince Based Products Preparation of fish mince based products, Surimi, Kamaboko, Hanpen, fish sausage, Analog and fabricated products.		
Module 3: Coated Fishery products Coated fishery products: Different types of batter and breading and its applications; preparation of coated fishery products (Fish ball, Fish finger, Fish cutlet, Fish cake, Fish burger, Sushi, Nobashi, Crab claw balls, Squid ring, Mussel products)		
Module 4: Ready to serve products in retortable pouch Preparation of products: Fish/prawn pickle, Prawn chutney powder, Fish soup powder, Fish curry.		
Module 5: Popular Fish/Prawn Products Preparation of products: Fish wafers, Fish papad, Fish noodles, Fish paste.		
Module 6: Marinated Products Types of marination and marinated fish products		
Module 7: Fish By-products Fish meal: Dry reduction and wet reduction methods, packaging and storage; Fish oil: body oil and liver oil, extraction, purification, preservation and storage, application of body and liver oil; Shrimp wastes - production of chitin and chitosan and their uses; Fish protein concentrate; Fish hydrolysate: partially hydrolyzed and deodorized fish meat, functional fish protein concentrate and the reincorporation to various products; Fish silage: acid silage and fermented silage and application; Fish maws; Shark leather; Fish glue; Fish gelatin; Isinglass; Pearl essence; Shark fin rays.		
REFERENCES		
1. Balachandran KK. 2002. Postharvest Technology in Fish and Fishery Products. Daya Publishing House. 2. Gopakumar K. 2006. Textbook of Fish Processing Technology. Indian Council of Agricultural Research. 3. Govindan TK. 1987. Fish Processing Technology. Oxford and IBH Publication Co. 4. Hall GM. 1992. Fish Processing Technology. Blackie 5. Biswas KP. 2020. Fish Processing and Preservation. Daya Publishing House.		

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC403P)	**VALUE ADDED FISH PRODUCTS (LAB)**	
CREDIT 2	**CLASS 60 HOURS**	**MARKS 50**
1. Fish filleting 2. Preparation of coated products (Fish finger and Fish ball)		

3. Preparation of fish/prawn pickle
4. Preparation of fish curry
5. Preparation of fish meal
6. Hands on training on value added fish products and report submission

COURSE OUTCOME
VALUE ADDED FISH PRODUCTS (FSCDSC403T)
Students will gather knowledge on different types of value added fish products like minced based, coated, marinated and ready to serve products as well as products that can be prepared from fish wastes.
VALUE ADDED FISH PRODUCTS (FSCDSC403P)
Students will be able to know the techniques of fish filleting; preparation of coated products; preparation of fish curry and fish meal. The hands on training program will provide them the practical exposure on preparation techniques of several value added fish products.

DISCIPLINE SPECIFIC COURSE (FSCDSC404T)	HATCHERY TECHNOLOGY

CREDIT 3	CLASS 45 HOURS	MARKS 50

Module 1: Introduction
Endocrine glands in fish with special emphasis on pituitary gland; Role of gonadotropin in fish breeding of carp and other cultivable fishes; Hypophysation of fish – collection of pituitary gland, preparation and preservation of pituitary extract, dosages and methods of injection; Uses of HCG, pheromones and synthetic drugs for induced breeding.

Module 2: Seed procurement
Selection of riverine spawn collection sites, gears used and methods of collection; Spawn quality and quantity indices; Advantages and disadvantages of riverine seed collection; Bundh breeding – types (wet and dry), collection and hatching eggs, factors involved in bundh breeding, advantages and disadvantages of bundh breeding.

Module 3: Hatchery Technology
Selection criteria for brood stock and their management; Different types of fish hatcheries - traditional, Chinese and glass jar hatcheries and their advantages and disadvantages.

Module 4: Seed Transportation
Packing of fish seed; Transport of fish seed and brood fishes - techniques of transport (open and closed systems), methods of transportation, use of anaesthetics, causes of mortality during transport.

Module 5: Hatchery Management
Water quality monitoring and management; Quarantine and disease management in hatcheries; Quality assessment of seeds.

REFERENCES

1. Jhingran VG and Pullin RSV. 1985. A Hatchery Manual for the Common, Chinese and Indian Major Carps. ICLARM, Philippines.'
2. Jhingran VG. 1997. Fish and Fisheries of India. Hindustan Publishing Corporation.
3. Pillay TVR and Kutty MN. 2011. Aquaculture: Principles and Management. Willey India Pvt. Ltd
4. Thomas PC. 2013. Breeding and Seed Production of Fin Fish and Shell Fish. Daya Publishing House
5. Rath RK. 2011. Freshwater Aquaculture. Scientific Publishers (India)
6. Harvey BJ and Hoar WS. 1979. The Theory and Practice of Induced Breeding in Fish. IDRC
7. Woynarovich E and Horváth L. 1980. The artificial propagation of warm-water finfishes - manual of extensions. FAO Fisheries Technical Paper, Rome.

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC404P)	HATCHERY TECHNOLOGY (LAB)

CREDIT 2	CLASS 60 HOURS	MARKS 50

1. Study of gonadal maturity stages in fishes
2. Collection, preparation and preservation of fish pituitary gland extract and dose calculation for IMC
3. Histological studies of ovary and testes

4. Freshwater fish farm visit and report submission

COURSE OUTCOME
HATCHERY TECHNOLOGY (FSCDSC404T)
Students will gather in depth knowledge on endocrine glands of fish and their role in fish reproduction; techniques of induced breeding of cultivable carps using pituitary extraction and synthetic hormones; techniques of collection of spawns from river, its advantages and disadvantages; types, advantages and disadvantages of bundh breeding; different types of hatcheries, their advantages and disadvantages; transportation of fish seed and techniques associated with it and steps to be followed for proper management of hatchery.
HATCHERY TECHNOLOGY (FSCDSC404P)
Students will be able to identify different maturity stages of fish gonads; prepare pituitary gland extract and calculate the required dose for induced breeding; identify histological slides of fish ovary and testis. The educational excursion will provide them the exposure on freshwater farm management as well as techniques followed there for breeding, hatching of eggs, rearing of spawns, fry and fingerlings.

INTERNSHIP (FSCHINT04P)	
CREDIT 4	**MARKS 50 (Project Report: 30; Viva-Voce: 20)**

SEMESTER V

DISCIPLINE SPECIFIC COURSE (FSCDSC501T)	FRESHWATER AQUATIC ECOLOGY	
CREDIT 3	**CLASS 45 HOURS**	**MARKS 50**
Module 1: Aquatic Ecosystem Types of fresh water ecosystem – lotic and lentic; Working of an ecosystem – Food chain, food web and energy flow; Productivity of water bodies; Bioconcentration, biomagnification, eutrophication; Aquatic pollution.		
Module 2: Pond Ecology Types of pond; Zones of freshwater pond; Abiotic and biotic components of the pond ecosystem; Habitats in the pond community; Outline idea on plankton, nekton, neuston and benthos.		
Module 3: Riverine Ecology Characteristics of lotic habitat; Adaptation of lotic animals; River zonation; Major river systems in India.		
Module 4: Lacustrine and Reservoir Ecology Classification of lakes; Zonation and stratification of lakes; Biological communities of lake; Definition and ecological features of reservoirs and its productivity.		
Module 5: Nutrient Cycle and Marine Habitat Nutrient cycles - Nitrogen, Phosphorous and Carbon; Law of limiting factor; Characteristics of marine habitat, zonation of marine habitat; Coral reefs- importance and threats.		
REFERENCES		
1. Sharma PD. 2011. Ecology and Environment. Rastogi Publications. 2. Odum EP. 1971. Fundamental of Ecology. W.B. Sounders Co. 3. Likens GE. 2010. Lake Ecosystem Ecology. Elsevier. 4. Likens GE. 2010. River Ecosystem Ecology. Elsevier.		

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC501P)	FRESHWATER AQUATIC ECOLOGY (LAB)	
CREDIT 2	**CLASS 60 HOURS**	**MARKS 50**
1. Water and soil quality management (pH, Temperature, Transparency, Conductivity; Dissolved Oxygen, Free Carbon di-oxide; Alkalinity, Hardness, Organic carbon) 2. Microscopic identification of phytoplankton and zooplankton from pond water		

COURSE OUTCOME
FRESHWATER AQUATIC ECOLOGY (FSCDSC501T)
Students will gather knowledge on basics of an aquatic ecosystem and different phenomena associated with it; basics of pond ecology and types of pond; major river systems of India, river ecology and adaptations associated with habitants of rhithron zone; lacustrine and reservoir ecology, types of lakes, thermal stratification in lakes; nutrient cycles; different zones of marine habitat; importance and threat of coral reefs.
FRESHWATER AQUATIC ECOLOGY (FSCDSC501P)
Students will be able to get hands on training on measurement of water pH, temperature, transparency, conductivity, dissolved oxygen, free carbon-di-oxide, alkalinity, hardness and soil carbon and identify common phyto- and zooplanktons.

DISCIPLINE SPECIFIC COURSE (FSCDSC502T)	INLAND AND MARINE FISHERY	
CREDIT 3	**CLASS 45 HOURS**	**MARKS 50**
Module 1: Riverine Fisheries		

Ganga river system: Fishing methods and representative ichthyofauna; Problems encountered in fisheries development of the Ganga River and its management.

Module 2: Coldwater Fisheries

Cold water fisheries resources of India; Ecological characters of cold water bodies of India; Representative species of fishes of cold water bodies of India; Prospect, problems and development of cold water fisheries in India.

Module 3: Reservoir and Lacustrine Fisheries

Major reservoirs and lakes in India - capture fisheries, fishing methods, problems encountered in fisheries development.

Module 4: Estuarine Fisheries

Definition and classification of estuaries; Important estuaries of India; Hooghly-Matla Estuary- capture fisheries, resident and migrant species, fishing methods, problems encountered in fisheries development of major estuaries; Backwater fishery resources of India and its potential; Mangroves and its potential.

Module 5: Marine Fisheries - Pelagic Resources

Marine fishery resources in India- important fishing zones including Wadge bank, maritime states. Major pelagic resource groups - sardines, mackerel, anchovies, ribbon fishes, tuna and Bombay duck. Methods of fishing of pelagic fisheries.

Module 6: Marine Fisheries - Demersal Resources

Major demersal resource groups- elasmobranchs, cephalopods, crabs, pomfrets, prawns and lobsters. Methods of fishing of demersal fisheries.

Module 7: Marine Fisheries - Deep Sea Resources

Major deep sea resources - fishes, shrimps and lobsters; Methods of fishing of deep sea fisheries.

REFERENCES

1. Jhingran VG. 1997. Fish and Fisheries of India. Hindustan Publishing Corporation.
2. Jhingran VG and Sehgal KL. 1978. Coldwater Fisheries of India. Inland Fisheries Society of India, Barrackpore.
3. Talwar PK and Kacker RK. 1984. Commercial Sea Fishes of India. Zoological Survey of India.
4. Singh HR and Lakra WS. 2008. Coldwater Aquaculture and Fisheries. Narendra Publishing House, New Delhi
5. Bal DV and Rao KV. 1990. Marine Fisheries of India. Tata McGraw-Hill, New Delhi
6. Kurien CV, Sebastian VO and Gopakumar K. 2002. Prawns and Prawn Fisheries of India. Hindustan Publishing Corporation
7. Samuel CT. 1968. Marine Fisheries in India. Oceanographic Laboratory, University of Kerala.
8. Handbook of Fisheries and Aquaculture, 2006. Indian Council of Agricultural Research.

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC502P)	INLAND AND MARINE FISHERY (LAB)	
CREDIT 2	**CLASS 60 HOURS**	**MARKS 50**

1. Identification of commercially important captured marine fishes (Oil sardine, Pomfret, Bombay duck, mackerel and ribbon fish)
2. Identification of commercially important shell fishes (*Penaeus monodon*, *Penaeus indicus*, *Litopenaeus vannamei, Pinctada fucata)*
3. Analysis of data, drawing of graphs, charts, histograms in relation to abundance and catch of particular fish
4. Educational excursion to a coastal fish landing centre and report submission

COURSE OUTCOME

INLAND AND MARINE FISHERY (FSCDSC502T)

Students will have basic knowledge on riverine and cold water fisheries, fishing methods, problems and management; reservoir, lacustrine and estuarine fisheries, fishing methods, problems; backwater fishery resources of India and its potential; mangrove and its potential; pelagic, demersal and deep sea fish resources and methods of fishing.

INLAND AND MARINE FISHERY (FSCDSC502P)

Students will be able to identify commercially important captured marine fishes and shell fishes; analyze the catch data and its representation in graphs/charts/ histograms. The educational excursion will provide them the exposure on the methods of survey and collection of data from a fish landing centre.

DISCIPLINE SPECIFIC COURSE (FSCDSC503T)	COASTAL AQUACULTURE AND MARICULTURE	
CREDIT 3	**CLASS 45 HOURS**	**MARKS 50**
Module 1: Introduction Selection of site, general planning and design of brackish water farms; Present status of brackish water aquaculture in India; Physicochemical parameters of brackish water.		
Module 2: Brackishwater Finfish Culture Cultivable species in brackish water systems. Culture practices – monoculture and polyculture of *Chanos chanos*, *Mugil cephalus* and *Etroplus suratensis.*		
Module 3: Shell Fish Culture Species of shrimps cultured in brackish water – *Penaeus monodon* and *Litopenaeus vannamei*. Extensive, semi-intensive and intensive shrimp farming practices. Species of crabs cultured and culture techniques.		
Module 4: Mariculture Open sea farming - scope and species cultured; Selection of site for sea farming; Different designs of open sea farming structures; Culture of seabass.		
Module 5: Molluscs and Seaweed Culture Mollusc culture – species of edible oysters, mussels and clams cultured; Important species of pearl oysters and methods of artificial pearl production; Culture of seaweeds, common cultivable species, culture techniques and harvesting, important seaweed products.		
REFERENCES		
1. Jhingran VG. 1997. Fish and Fisheries of India. Hindustan Publishing Corporation. 2. Bardach JE, Ryther JH and McLarney WO. 1974. Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms. John Willy & Sons Ltd. 3. Pillay TVR and Kutty MN. 2011. Aquaculture: Principles and Management. Willey India Pvt. Ltd 4. Kurien CV, Sebastian VO and Gopakumar K. 2002. Prawns and Prawn Fisheries of India. Hindustan Publishing Corporation 5. Thomas PC. 2013. Breeding and Seed Production of Fin Fish and Shell Fish. Daya Publishing House 6. Milne PH. 1972. Fish and Shell Fish Farming in Coastal Waters. Fishing News. 7. McVey JP. 1983. Handbook of Mariculture. CRC Press 8. Chakraborty C and Sadhu AK. 2000. Biology, Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn. Daya Publishing House.		

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC503P)	COASTAL AQUACULTURE AND MARICULTURE (LAB)	
CREDIT 2	**CLASS 60 HOURS**	**MARKS 50**
1. Identification of some common marine and brackish water finfish (*Chanos chanos*, *Mugil cephalus*, *Etroplus suratensis*, *Lates calcarifer*) 2. Identification of cultivable seaweeds (*Gracilaria sp.*, *Ulva sp.*, *Laminaria sp.*) 3. Analysis of salinity, phosphate and nitrate of water 4. Educational visit to a brackish water fish farm and report submission		

COURSE OUTCOME
COASTAL AQUACULTURE AND MARICULTURE (FSCDSC503T)
Students will have basic knowledge on factors of consideration for selection of brackish water fish farm; planning and design for starting a brackish water fish farm; culture of different brackish water fin fishes; culture of economically important shrimp and crab; open sea farming and culture of seabass; culture of

edible oysters, mussels, clams; pearl culture and culture of economically important seaweeds.

COASTAL AQUACULTURE AND MARICULTURE (FSCDSC503P)

Students will be able to identify common cultivable marine and brackish water fin and shell fishes and common seaweeds; analyze salinity, nitrate and phosphate of water sample. The educational excursion will provide them the exposure on management procedures for a brackish water fish farm.

DISCIPLINE SPECIFIC COURSE (FSCDSC504T)	FISHING CRAFT AND GEAR TECHNOLOGY	
CREDIT 3	**CLASS 45 HOURS**	**MARKS 50**

Module 1: Fishing Crafts

Boat building material - wood, steel, aluminum and FRP -advantages and disadvantages; Wood preservation techniques; Classification and description of different type of fishing crafts in India (inland and marine) - traditional, motorized and mechanized; General arrangements of different type of fishing boats, trawlers, gill netters, purse seiners, long liners, trollers, deep sea vessels.

Module 2: Fishing Gears

Traditional and modern fishing gears; Fishing gear materials - natural and synthetic, properties and preservation, types of knots, knotless netting, meshes; Mounting and webbing- different methods, hanging co-efficient; Modern commercial fishing methods- Operation and classification of trawling, purse seining, lampara net fishing, gill netting, line fishing; Squid jigging; Fishing accessories-hooks, floats, sinkers and ropes.

Module 3: FAD's, Fish Finding Devices and Conservation

Fish aggregating devices and artificial reefs; Impact of artificial reefs on fish stock improvement; Turtle Exclusion Devices (TED); By-catch Reduction Devices (BRD); Fish finder; GPS navigator; Remote sensing.

Module 4: Responsible Fisheries and Fisheries Legislation

Concept of Responsible Fisheries; Monsoon trawl ban, closed season, mesh size regulations, juvenile fishing, Exclusive Economic Zone (EEZ), Coastal Regulation Zone (CRZ), Integrated Coastal Zone Management (ICZM), MSY, MEY, Over fishing, Recruitment over fishing, Aquaranching.

REFERENCES

1. Biswas KP. 2012. Advancement in Fish, Fisheries and Technology. Narendra Publishing House.
2. Badapanda KC. 2013. Fishing Crafts and Gear Technology. Narendra Publishing House.
3. Gabriel O, Lange K, Dahm E and Wendt T. 2005. Von Brandt's Fish Catching Methods of the World. Wiley
4. George VC. 1971. An account of the Inland Fishing Gears and Methods of India. Central Institute of Fisheries Technology, Indian Council of Agricultural Research
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6. Klust G. 1982. Netting materials for fishing gear, FAO, Fishing News Books (Ltd), England.
7. Sainsbury JC. 1989. Commercial Fishing Methods: An introduction to Vessels and Gear. Wiley-Blackwell
8. Sreekrishna Y and Shenoy L. 2001. Fishing Gear and Craft Technology, Indian Council of Agricultural Research, New Delhi.
9. Badapanda, KC. 2018. Fisheries Legislation. Laxmi Publications Pvt. Ltd.
10. Pandey DK and De HK. 2014. Fisheries Governance And Legislation In India. Narendra Publishing House, New Delhi.

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC504P)	FISHING CRAFT AND GEAR TECHNOLOGY (LAB)	
CREDIT 2	**CLASS 60 HOURS**	**MARKS 50**

1. Identification of fishing gears (Cast net, gill net, purse seine net, hook and line, common traps)
2. Identification of fishing accessories (floats, ropes, sinkers, swivels, shackles, fishing rods)

3. Identification of synthetic and natural fibres 4. Different types of hooks and baits

COURSE OUTCOME
FISHING CRAFT AND GEAR TECHNOLOGY (FSCDSC504T)
Students will be able to know about different types of fishing crafts; different types of fishing gears and their mode of use; fishing accessories; different types of fish finding devices; devices used for conservation of fishes; concept of responsible fisheries; different steps to combat over fishing etc.
FISHING CRAFT AND GEAR TECHNOLOGY (FSCDSC504P)
Students will be able to identify common fishing gears; different fishing accessories like floats, ropes, sinkers, swivels, shackles and fishing rods; synthetic and natural fibres and different types of hooks and baits.

SEMESTER VI

DISCIPLINE SPECIFIC COURSE (FSCDSC601T)	FISH PATHOLOGY AND IMMUNOLOGY	
CREDIT 3	**CLASS 45 HOURS**	**MARKS 50**
Module 1: Common Infectious Diseases of Finfish Viral (VHS), Bacterial (Infectious Abdominal Dropsy, Bacterial tail and fin rot), Fungal (Saprolegniasis and Brachiomycosis), Protozoan (Ichthyophthiriasis, Trichodiniasis, Whirling disease) - causative agents, symptom of disease, prophylaxis and treatment; Metazoan (Dactylogyrosis, Gyrodactylosis, Lernaeosis, Argulosis) - morphology and life cycle, symptom of disease, prophylaxis and treatment; Epizootic Ulcerative Syndrome.		
Module 2: Common Diseases of Shellfish Some common diseases of prawn: IHNV, Baculovirus, Black gill disease, White spot disease - causative agents, symptoms, prophylaxis and treatment.		
Module 3: Nutritional and Environmental Diseases Nutritional pathology- Vitamin and mineral deficiency diseases (nutritional cataract, fish anaemia, enlarged liver, lordosis and scoliosis); Environmental diseases- Gas bubble disease, alkalosis, acidosis and aflatoxicosis.		
Module 4: Fish Health Management General preventive methods and prophylaxis; Methods for disease control and management - chemotherapeutic agents, host management, prophylaxis (vaccines, adjuvants, immunostimulants and probiotics); Use and abuse of antibiotics and chemicals in health management; Fish health and quarantine systems; Seed certification, SPF and SPR; Evaluation criteria of healthy seeds.		
Module 5: Immunology Introduction to fish immunology and terminologies; Defense system and mechanism in fish and shellfish: innate and acquired immunity; Application and development of vaccines and antibiotics.		
REFERENCES		
1. Nair PR. 1993. Encyclopedia of Fish Diseases (Vol. 1 and Vol. 2). Dominant Publishers and Distributors. 2. Biswas KP. 2007. Prevention and Control of Fish and Prawn Diseases. Narendra Publishing House. 3. Mishra BK, Swain P, Sahoo PK, Das BK and Sarangi N. 2007. Disease Management in Fresh Water Pisciculture. Soujanya Books. 4. Thanwal R. 2014. A Handbook of Fish Diseases. Astha Publishers & Distributors. 5. Noga EJ. 2010. Fish Disease: Diagnosis and Treatment. Wiley-Blackwell. 6. Das MK and Das RK. 1997. Fish and Prawn Diseases of India: Diagnosis and Control. Inland Fisheries Society of India, Barrackpore. 7. Anderson DP. 2003. Text Book of Fish Immunology. Narendra Publishing House. 8. Amlacher E, Conroy DA and Herman LR. 1970. Textbook of Fish Diseases. T.F.H. Publications.		

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC601P)	FISH PATHOLOGY AND IMMUNOLOGY (LAB.)	
CREDIT 2	**CLASS 60 HOURS**	**MARKS 50**
1. Identification of ornamental fish disease- tail and fin rot, dropsy, white-spot, cotton wool, trichodiniasis, whirling disease. 2. Identification of some common fish pathogen - *Argulus*, *Dactylogyrus*, *Gyrodactylus*, *Lernaea, Ichthyopthirius*, *Trichodina*, *Myxobolus*. 3. Identification of common shellfish disease - IHNV, Baculovirus and Black gill disease		

COURSE OUTCOME
FISH PATHOLOGY AND IMMUNOLOGY (FSCDSC601T)
Students will acquire knowledge on common infectious diseases of finfish and shell fishes; nutritional and

environmental diseases of finfish; measures associated with fish health management and fish immunology.
FISH PATHOLOGY AND IMMUNOLOGY (FSCDSC601P)
Students will be able to identify common diseases of finfish and shell fish as well as common fish pathogens.

DISCIPLINE SPECIFIC COURSE (FSCDSC602T)	**AQUACULTURE NUTRITION**	
CREDIT 3	**CLASS 45 HOURS**	**MARKS 50**
Module 1: Nutrient requirement of fish and Feed ingredients Role of nutrients: proteins and amino acids, fatty acids and lipids, carbohydrates, vitamins and minerals; Role of natural food in fish nutrition; Feed additives - pigments, immunostimulants, chemo-attractants, growth promoters, preservatives; Anti-nutritional factors. Criteria for the selection of ingredients for feed preparation. Different feed ingredients- animal, plant, microbial in origin, Fish meal, SCP, silages, fermented products; Outline idea on proximate composition and chemical evaluation.		
Module 2: Fish Feed and Feed Manufacturing Types of feed: dry (pellets, flakes and powdered) and non-dry; Feed formulation methods - Pearson's method; Feed manufacturing equipment and processes: pulverizer, mixer, pelletizer, extruder/ expander, drier, vacuum coater; Different size and grades of fish / shrimp feeds -starter, grower and finisher feeds.		
Module 3: Feed Management Feeding strategies - feed ration, feeding frequency and feeding methods (check trays, demand feeders and automatic feeders); Feed storage: hydro-stability of feed and their storage; Storage problems - spoilage from rancidity, fungus and associated toxins and pest and their prevention.		
Module 4: Feed Quality Evaluation Feed Conversion Ratio and Feed Conversion Efficiency; Protein Efficiency Ratio; Net Protein Utilization; Biological Value; Specific Growth Rate; Average Weight Gain; Average Daily Gain; Survival Rate; EAAI; Chemical Score. Physical properties of feed: water stability, bulk density, water absorption, expansion ratio and sinking velocity; Leaching.		
REFERENCES		
1. Halver JE and Hardy RW. 2002. Fish nutrition. 3rd Edition. Academic Press. 2. Stefens W. 1989. Principles of fish nutrition. John Wiley & Sons. 3. De Silva SS and Anderson TA. 1994. Fish nutrition in aquaculture. Chapman and Hall. 4. Lovell RT. 1998. Nutrition and Feeding of Fishes. Chapman and Hall. 5. Halver JE and Tiews KT. 1979. Finfish Nutrition and Fish Feed Technology. Vol. 1 and 2. Heenemann, Berlin.		

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC602P)	**AQUACULTURE NUTRITION (LAB)**	
CREDIT 2	**CLASS 60 HOURS**	**MARKS 50**
1. Feed formulation and preparation 2. Determination of sinking rate and water stability of feed 3. Estimation of physical properties of feed: bulk density, water absorption and expansion ratio 4. Visit to a fish feed processing farm and report submission		

COURSE OUTCOME
AQUACULTURE NUTRITION (FSCDSC602T)
Students will gather knowledge on basics of fish nutrition; fish additives; anti-nutritional factors; different types of fish feed ingredients; types of fish feed and methods of feed formulation and preparation; different grades of fish and shrimp feed; feed management and feeding methods; feed storage and related problems and assessment of feed quality.
AQUACULTURE NUTRITION (FSCDSC602P)

Students will be able to formulate and prepare farm made feed and assess some important physical properties of fish feed. The educational visit to a fish feed processing farm will provide them the exposure on steps followed for commercial fish feed preparation in an industry.

DISCIPLINE SPECIFIC COURSE (FSCDSC603T)	LARVAL DIET AND LIVE FISH FOOD ORGANISMS	
CREDIT 3	**CLASS 45 HOURS**	**MARKS 50**
Module 1: Larval Nutrition Nutritional quality requirements of larval feeds; Types of larval feed [powdered, micro-encapsulated, micro-bound and micro-coated diets, Particle Assisted Rotationally Agglomerated microparticulate diet (PARA); Marumerized Extruded Microparticulate diet (MEM) and nano diets]; Culture of single cell proteins and their nutritional quality.		
Module 2: Biology of live food organisms Candidate species of phytoplankton and zoo-plankton as live food organisms of freshwater species; Proximate composition, morphology and reproductive biology of important live food organisms (*Chlorella*, *Spirulina*, infusoria, rotifers, cladocerons, tubifex, brine shrimp and chironomids).		
Module 3: Culture of live food organisms Culture of important live food organisms - *Chlorella*, *Spirulina*, infusoria, rotifers, cladocerons, tubifex, brine shrimp and chironomids; Bio-enrichment of rotifer and brine shrimp; Culture of earthworms (vermicompost); Culture of bait fish and forage fish.		
REFERENCES		
1. Holt GJ. 2011. Larval fish nutrition. John Wiley & Sons. 2. Hellweg M. 2008. Culturing Live Foods: A Step-by-Step Guide for Culturing One's Own Food for the Home Aquarium. TFH Publications. 3. Athithan S. 2021. Textbook On Fish Food Organisms. Daya Publishing House.		

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC603P)	LARVAL DIET AND LIVE FISH FOOD ORGANISMS (LAB)	
CREDIT 2	**CLASS 60 HOURS**	**MARKS 50**
1. Identification of some common live fish feed (tubifex, brine shrimp and chironomids) 2. Culture of infusoria 3. Culture of green algae 4. Culture of brine shrimp 5. Culture of rotifer		

COURSE OUTCOME
LARVAL DIET AND LIVE FISH FOOD ORGANISMS (FSCDSC603T)
Students will get the knowledge on nutritional requirement of fish larvae; proximate composition, morphology, reproductive biology and culture of common live fish feed organisms.
LARVAL DIET AND LIVE FISH FOOD ORGANISMS (FSCDSC603P)
Students will be able to identify some common live fish feed organisms and will get the practical knowledge on culture of infusoria, green algae, brine shrimp and rotifer.

DISCIPLINE SPECIFIC COURSE (FSCDSC604T)	BIOSTATISTICS AND COMPUTER APPLICATION	
CREDIT 3	**CLASS 45 HOURS**	**MARKS 50**
Module 1: Biostatistics Definition of statistics; Concepts of population and sample; Classification of data; Methods of data collection; Biological data collection; Diagrammatic and graphical representation of data - bar diagrams,		

pie-diagram, histogram; Important measures of central tendency - arithmetic mean, median and mode; Important measures of dispersion: mean Deviation, standard deviation and quartile deviation; Coefficient of variation; Basics of probability; Tests of significance based on Normal, t, and Chi-square distributions; Scatter diagram; Relation between correlation and regression; Length weight relationship in fishes.

Module 2: Computer Application

Computer organization - input and output devices; Binary system; Operating systems (OS) - definition, basic concepts, introduction to WINDOWS, LINUX and ANDROID Operating Systems; Local Area network (LAN), Wide area network (WAN); Types of programming languages (Machine languages, Assembly languages, high level languages); Data organization (Drives, Files, Directories); Types of memory (primary and secondary), RAM, ROM, PROM, EPROM. Secondary storage devices (FD, CD, HD, Pen drive); I/O Devices (Scanner, Plotters, Plasma Display); Numbering system and introduction to Binary; Microprocessor.

Office application software; Word Processors; Spreadsheet; Presentation; Data Base Management; SQL

Introduction to the World Wide Web; Basics of web development using HTML; Creation of email accounts; Application of Search Engines.

REFERENCES

1. Antonisamy B, Premkumar PS and Christopher S. 2017. Principles and Practice of Biostatistics. Elsevier India.
2. Rao VK. 2009. Biostatistics: A Manual of Statistical Methods for Use in Health, Nutrition and Anthropology. Jaypee Brothers Medical Publishers.
3. Chap T Le and Eberly LE. 2016. Introductory Biostatistics. John Wiley and Sons Inc.
4. Courter G and Marquis A. 1999. Microsoft Office Professional. B.P.B Publication, New Delhi.
5. Jaggi VP and Jain S. 1993. Computer for Beginners. Academic Publications. New Delhi.
6. Dyson P and Coleman P. 2000. Windows 2000 Professional. B.P.B Publication, New Delhi.
7. Ra, B. 1997. Computer Fundamentals. New Age International Publishers, New Delhi.
8. Taxali RK. 1998. PC Software for Windows Made Simple. Tata McGraw Hill Publishing Company Ltd., New Delhi.
9. Balaguruswami E. 1991. Programming on BASIC. Tata McGraw- Hill Publishing Company, New Delhi.
10. Goel SK. 1999. Computer and Internet Management. Vol.1. Rajat Publications, Delhi.

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC604P)	BIOSTATISTICS AND COMPUTER APPLICATION (LAB)	
CREDIT 2	**CLASS 60 HOURS**	**MARKS 50**

1. Calculation of mean, median and mode
2. Calculation of mean deviation, standard deviation and quartile deviation
3. Length weight relationship studies in fishes
4. Formatting a document using Microsoft word
5. Use of mail merge
6. Use of internet to collect fisheries data and research related information

COURSE OUTCOME

BIOSTATISTICS AND COMPUTER APPLICATION (FSCDSC604T)

Students will gather knowledge on basic statistical methods like probability, chi-square test, t-test, analysis of variance, measures of central tendency and dispersion, regression and correlation, collection of biological data, classification and tabulation, basics of computer like input-output devices, binary system, operating system, programming languages, data organization, drives, files, directories, memory, RAM, ROM, PROM, EPROM, secondary storage devices, I/O Devices, Numbering system and introduction to binary, microprocessor, office applications software, word processors, spreadsheet, presentation, data base management, SQL, basics of web development using HTML, creation of email accounts, application of search engines etc.

BIOSTATISTICS AND COMPUTER APPLICATION (FSCDSC604P)

Students will be able to understand methods for calculation of mean, median, mode, standard deviation, mean deviation and quartile deviation; measurement of length weight relationship in fish; formatting

document using Microsoft word; use of mail merge and collection of fisheries data and research related information using internet.

INTERNSHIP (FSCHINT06P)	
CREDIT 4	**MARKS 50 (Project Report: 30; Viva-Voce: 20)**

SEMESTER VII

DISCIPLINE SPECIFIC COURSE (FSCDSC701T)	ENTREPRENEURSHIP DEVELOPMENT

CREDIT 3	CLASS 45 HOURS	MARKS 50

Module 1: Introduction

Concept of entrepreneurship; Ability, capability and willingness to build up enterprise; importance of entrepreneurship; Process of entrepreneurship; development; Enterprise- definition, characteristics, functions; Difference between entrepreneur and manager; Intrapreneurship.

Module 2: Human Resource Management

Definitions and approaches, scope and importance of management; Comparative management; Functions of Managers; Environment impact management; Planning, organizing, staffing, directing and controlling; Contributions of Henry Fayol to the Scientific Techniques of management; Manpower planning and recruitment; Organizational Development- Training, Motivation, Morale and Productivity, Leadership, Organizational communication, Conflicts and Decision making; Important Institutions involved in human resource development in Fisheries sector.

Module 3: Processing Sector Management and Project Formulation

Organizational setup in processing Industries; State Fisheries Department; Role of EIA, MPEDA and CIFT in the processing Industry; India's share In the International trade of sea foods; Project formulation; Process identification; Pre feasibility- technical, Economical and Social feasibility; Concept of capital budgeting and Its importance; Socially and financially viable indicators- CI, EG, RoR, DCF, NPV, IRR, and sensitivity analysis; CPM, PERT and Decision making.

Module 4: Fisheries Acts

Indian fisheries Act; National Institutions of Governance in Marine affairs of India; Criteria for regulation of Fishing effort; Code of conduct for responsible fisheries; WTO.

Module 5: Marketing Management

Market management- Concepts of Marketing, market mix, market segmentation, factor determining the buying decisions; Channels of distribution; Determining the selling price- Price spread, advertising and sales promotion.

Module 6: Cooperatives and Agencies in Fisheries

Definition and principles of co-operatives; Role of National Cooperative development Corporation (NCDC), Matsyafed, National Federation of Fishermen cooperatives, FFDA, BFFDA, ADAK, BENFISH, SFDC; Problems of Fishery Cooperatives; Cooperatives and their importance in fish production and marketing; Role of NABARD and SIDBI.

REFERENCES

1. Gangopadhyay D. 1998. Enterprise and Entrepreneur. Basabi Gangopadhayay.
2. Khanka SS. 2007. Entrepreneurial Development. S Chand & Company.

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC701P)	ON JOB TRAINING

CREDIT 2	CLASS 60 HOURS	MARKS 50

1. On Job Training

COURSE OUTCOME

ENTREPRENEURSHIP DEVELOPMENT (FSCDSC701T)

Students will gather knowledge on basic concept of entrepreneurship; role of management and manager; different aspects of human resource management; institutions involved in human resource development in Fisheries sector; processing sector and management protocols; role of EIA, MPEDA and CIFT in the processing Industry; project formulation; concept of capital budgeting and its importance, socially and financially viable indicators and sensitivity analysis, CPM, PERT and decision making; different fisheries act and responsible fisheries; concepts of marketing, determination of buying decisions, channels of distribution, determination of the selling price; cooperatives and agencies in fisheries and their role in fish

production and marketing, role of NABARD and SIDBI.
ON JOB TRAINING (FSCDSC701P)
Students will have industry exposure where they will receive training at a processing institute/industry. This will help them to prepare themselves before taking forward steps for a job life after graduation.

DISCIPLINE SPECIFIC COURSE (FSCDSC702T)	**FISHERIES ECONOMICS**	
CREDIT 3	**CLASS 45 HOURS**	**MARKS 50**
Module 1: Principles of Economics and Marketing Definition and scope of economics; Law of diminishing returns, laws of increasing, constant and decreasing utility returns; Law of equimarginal returns; Importance of economics in aquaculture development; Markets and their kinds; Law of demand and supply, price determination, problems of fish marketing in India; Exports of fish and fishery products, trends and problems therein.		
Module 2: Economy of Fishermen Fishermen populations; GDP from fisheries sector; Foreign exchange earnings and employment potential of fishing industry.		
Module 3: Fishery Livelihood Modes of fisheries management - Open access, regulated, advisory; participatory, user rights; International fishery regulations, treaties and instruments; Input control measures such as access control, size, type, number and power of boats, duration of fishing; Output control measures such as Total Allowable Catch, Catch Quotas, Licensing; Technical control measures such as size limitations, closed fishing areas, closed seasons, size of nets and mesh size regulations, limited entry; Impediments to fisheries governance; Basic concept and role of UNCLOS; Vulnerability of fishers to changes in resource availability, exploitation and utilization patterns; Marginalization of fishermen, small scale processors and traders due to changing scenarios of product diversification, markets and trade; Impact of dams, river linking, CRZ, Biodiversity Bill, protected/closed area, fishing bans, closed seasons, mangroves, sanctuaries and parks on the fisher communities; Land and water body use issues in fisheries; Role of extension in fisheries, mechanisms and modes of extension and their impact on capture fisheries and fisher's livelihood, alternative livelihood options; Management of conflicts within sub-sectors in fisheries; Women in fisheries, status, role, impact and future; Vulnerability of fishers to natural disasters and coping mechanisms in disaster management.		
REFERENCES		
1. Mithani DM. 2021. Principles of Economics. Himalaya Publishing House Private Limited. 2. Stonier AW and Hague DC. 1980. A Textbook of Economic Theory. Longman Higher Education. 3. Lawson RM. 2013. Economics of Fisheries Development. Bloomsbury Publishing. 4. Turvey R and Wiseman J. 1956. The Economics of Fisheries. FAO. 5. Saxena A. 2012. Fisheries Economics. Daya Publishing House 6. Saxena A. 2011. Fisheries Extension. Daya Publishing House. 7. Ray GL. 2015. Extension, communication and management. Kalyani Publishers.		

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC702P)	**FISH MARKET SURVEY**	
CREDIT 2	**CLASS 60 HOURS**	**MARKS 50**
1. Fish Market Survey		

COURSE OUTCOME
FISHERIES ECONOMICS (FSCDSC702T)
Students will have knowledge on basics of economics and marketing; problems of fish marketing in India; exports of fish and fishery products, trends and problems; GDP of India from fisheries sector and foreign exchange earnings and employment potential of fishing industry; modes of fisheries management; international fishery regulations, treaties and instruments; input and output control measures;, technical control measures; vulnerability of fishers to changes in resource availability, exploitation and utilization

patterns, marginalization of fishermen, small scale processors and traders due to changing scenarios of product diversification, markets and trade; impact of dams, river linking, CRZ, Biodiversity Bill, protected/closed area, fishing bans, closed seasons, protected areas, mangroves, sanctuaries and parks on the fisher communities; role of extension in fisheries; women in fisheries, status, role, impact, future; vulnerability of fishers to natural disasters and coping mechanisms in disaster management.
MARKET SURVEY (FSCDSC702P)
Students will gather basic knowledge on methods of market survey, how to collect and analyze data, data representation and finally how to write a scientific report based on available data.

SPECIAL MINOR COURSE (SM-1)			
SM-1	**CREDIT 3**	**CLASS 45 HOURS**	**MARKS 50**
SM-1-P	**CREDIT 2**	**CLASS 60 HOURS**	**MARKS 50**

SPECIAL MINOR COURSE (SM-2)			
SM-2	**CREDIT 3**	**CLASS 45 HOURS**	**MARKS 50**
SM-2-P	**CREDIT 2**	**CLASS 60 HOURS**	**MARKS 50**

SEMESTER VIII

DISCIPLINE SPECIFIC COURSE (FSCDSC801T)	FISH MICROBIOLOGY

CREDIT 3	CLASS 45 HOURS	MARKS 50

Module 1: Introduction
General characteristics of bacteria, fungi, viruses, algae and protozoans.

Module 2: Structure of microbes
Structure and function of bacterial cell wall, plasma membrane, capsule, flagella and endospore; Structure of fungi and yeast cell; Structure of bacterio-phage, lytic and lysogenic cycle.

Module 3: Isolation and culture of microbes
Prokaryotic growth – characteristic features of bacterial growth curve; Effect of environmental factors on growth; Nutrition and growth of bacteria – different types of media for isolation of bacteria and fungi; Isolation and culture of bacteria and fungi from water and sediment; Different culture techniques.

Module 4: Aquatic Microbiology
Micro-flora of aquatic environment; Autotrophic and heterotrophic microorganisms in aquatic environment; Health significant bacteria in culture ponds; Culture characteristics and epidemiology of *E. coli*, pathogenic *Vibrio sp.*, *Salmonella sp.*, and *Pseudomonas sp.*

Module 5: Fish Microbiology
Perishability of seafood – Microbial spoilage of fish and shell fish; Spoilage microflora; Intrinsic and extrinsic factors affecting spoilage; Microflora associated with body parts; Food borne pathogens; Sources of contamination.

REFERENCES

1. Pelczar MJ, Chan ECS and Krieg NR. 2001. Microbiology. McGraw Hill Education.
2. Willey JM, Sherwood LM and Woolverton CJ. 2007. Prescott, Harley, and Klein's Microbiology. McGraw-Hill Science Engineering.
3. Fernandes R. 2009. Microbiology Handbook: Fish and Seafood. Leatherhead Publishing and Royal Society of Chemistry, Cambridge.
4. Parthiban F and Felix S. 2018. Microbiology of Fish and Fishery Products. Astral International Pvt. Limited.

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC801P)	FISH MICROBIOLOGY (LAB)

CREDIT 2	CLASS 60 HOURS	MARKS 50

1. Sterilization technique - dry heating and autoclaving
2. Media preparation
3. Isolation and maintenance of bacteria from fishes and water.
4. Gram staining of bacteria
5. Enumeration of bacteria by TPC method
6. Enumeration of total coliforms (MPN technique)

COURSE OUTCOME

FISH MICROBIOLOGY (FSCDSC801T)

Students will become knowledgeable on general microbiology in terms of bacteria, fungi, viruses, algae and protozoa; structure of different microbes; bacterial growth; effect of environmental factors on bacterial growth; different types of media used for isolation of bacteria and fungi; isolation and culture of bacteria and fungi from water and sediment; different culture techniques; aquatic microflora; health significant and pathogenic bacteria; spoilage of fish and shell fish; spoilage microflora and factors affecting spoilage; food borne pathogens and sources of contamination.

FISH MICROBIOLOGY (FSCDSC801P)

Students will get practical knowledge on sterilization techniques; preparation of different media; isolation and growth of bacteria; gram staining and enumeration of bacteria by different techniques.

DISCIPLINE SPECIFIC COURSE (FSCDSC802T)	FISH GENETICS AND BIOTECHNOLOGY	
CREDIT 3	**CLASS 45 HOURS**	**MARKS 50**
Module 1: Basic Genetics Structure of Chromosome and DNA; Knowledge of gene, Genotypes & Phenotypes; Principles of genetics; Mendel's law of inheritance - allelic and non-allelic interactions of genes – complete, incomplete, pleotropism, epistasis, supplementary and complementary genes; DNA Replication.		
Module 2: Selection and Hybridization Principles of breeding - methods and selection, selective hybridization, intra-specific and inter-specific hybridization – GIFT tilapia; Hybrid vigor, inbreeding and cross breeding.		
Module 3: Sex Determination Practical application of genetics in aquaculture; Genetics of sex determination in fish; Gonochorism, Hermaphroditism, Protandry and Protogyni; Environmental Influence of sex determination.		
Module 4: Aquaculture Biotechnology Recombinant DNA technology; Aquaculture biotechnology- Biotechnological tools for aquaculture, gene manipulation in fish, transgenic fish production.		
Module 5: Chromosome Manipulation in Fish Polyploidy, gynogenesis and androgenesis; Monosex production - super male and super female fish production techniques; Sex reversal - methods; Cryopreservation of gametes.		
Module 6: Marine Biotechnology Marine toxins; Industrial chemicals and pharmaceuticals from marine sources.		
REFERENCES		
1. Purdom CE. 1992. Genetics and Fish Breeding. Springer Dordrecht. 2. Nair PR. 2008. Biotechnology and Genetics in Fisheries and Aquaculture. Dominant Publishers And Distributors. 3. Padhi BK and Mandal RK. 2000. Applied Fish Genetics. Fishing Chimes. 4. Pandian TJ, Strüssmann CA and Marian MP. 2005. Fish Genetics and Aquaculture Biotechnology. CRC Press. 5. Reddy PVGK, Ayyappan S, Thampy DM and Krishna G. 2005. Fish Genetics and Biotechnology. Indian Council for Agricultural Research. 6. Dunham RA. 2011. Aquaculture and Fisheries Biotechnology: Genetic Approaches. CABI. 7. Malvee S. 2008. Fish Genetics. SBS Publishers and Distributors.		

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC802P)	FISH GENETICS AND BIOTECHNOLOGY (LAB)	
CREDIT 2	**CLASS 60 HOURS**	**MARKS 50**
1. Mitotic and meiotic chromosome preparation and their identification in fish 2. Karyotype study 3. Isolation of DNA from fish blood		

COURSE OUTCOME
FISH GENETICS AND BIOTECHNOLOGY (FSCDSC802T)
Students will get the knowledge on basics of genetics; concepts of hybridization and techniques involved; determination of sex and sex reversal in fish; aquaculture biotechnology; chromosome manipulation and cryopreservation of gametes and marine biotechnology.
FISH GENETICS AND BIOTECHNOLOGY (FSCDSC802P)
Students will be able to prepare mitotic and meiotic chromosome and identify the stages of cell division; study of karyotype and isolate DNA from fish blood.

DISCIPLINE SPECIFIC COURSE (FSCDSC803T)	BIOCHEMISTRY AND QUALITY ASSURANCE

CREDIT 3	CLASS 45 HOURS	MARKS 50

Module 1: Biochemistry

Importance of biochemistry in fisheries and food technology; Basic structure, classification and properties of carbohydrate; Basic structure, classification and properties of proteins; Essential and non-essential amino acids; Basic structure, classification and properties of lipid; Enzymes (classification, mode of action, factors controlling enzymatic activity, Michaelis - Menten Equation).

Module 2: Quality Control In Fish Processing Industry

Different types of spoilage in fishery products – chemical, physical and biological spoilage; Waste management in fish processing industries; Sanitation procedures in sea food processing plants; Basic concepts of quality and quality control; Necessity for quality control and factors controlling quality parameters.

Module 3: Quality Hazards in Seafood Industry

Salient features of sea food quality; Risk factors in sea food biotoxins; Sea food pathogens, endogenous parasites, physical, chemical and biological hazards; Precautions to be taken to avoid hazards in seafood industry.

Module 4: Quality Assurance

Methods of evaluating fish freshness and quality – organoleptic, sensory, physical, chemical, microbiological and instrumental methods. Sampling systems followed in processing plants for testing the quality.

Module 5: Quality Control Programs

Pre-shipment inspection, IPQC, MIPQC, HACCP and ISO Series in seafood industry; Principles involved in HACCP system; Implementation of HACCP- hazard analysis, critical control point and critical limit; Export of fishery products from India – major countries, important products, export documents and procedures; Traceability, Quality certifications, Eco-labeling; Outline idea on FSSAI.

REFERENCES

1. Das D. 2015. Biochemistry. Academic Publishers.
2. Nelson DL and Cox MM. 2017. Lehninger Principles of Biochemistry. WH Freeman.
3. Voet D and Voet JG. 2010. Biochemistry. Wiley.
4. Sankar TV, Mukundan MK and Balasubramanian S. 2011. Manual on Seafood Quality Assurance. CIFT.
5. Balachandran KK. 2002. Postharvest Technology in Fish and Fishery Products. Daya Publishing House.
6. Gopakumar K. 2006. Textbook of Fish Processing Technology. Indian Council of Agricultural Research.
7. Govindan TK. 1987. Fish Processing Technology. Oxford and IBH Publication Co.

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC803P)	BIOCHEMISTRY AND QUALITY ASSURANCE (LAB)

CREDIT 2	CLASS 60 HOURS	MARKS 50

1. Qualitative test of carbohydrate, protein and lipid
2. Physical and chemical analysis of quality of fish
3. Visit to a fish processing industry and report submission

COURSE OUTCOME

BIOCHEMISTRY AND QUALITY ASSURANCE (FSCDSC803T)

Students will gather knowledge on basics of biochemistry in terms of carbohydrate, protein, Amino acid and lipid, their structure, classification and properties; classification and action of enzymes; quality control in fish processing industry; sea food pathogens; different types of hazards in seafood industry and measures to avoid the hazards; methods of analyzing the freshness of fish and sampling method for testing the quality of fish in processing plants; details on Hazard Analysis and Critical Control Point and quality standard management.

BIOCHEMISTRY AND QUALITY ASSURANCE (FSCDSC803P)

Students will be able to analyze the presence of carbohydrate, protein and lipid in samples and will also

be able to identify the quality of a fish analyzing physical and chemical properties. The educational visit to the fish processing farm will provide them the exposure on techniques and steps followed for fish processing in a commercial processing farm.

DISCIPLINE SPECIFIC COURSE (FSCDSC804T)	TOOLS AND TECHNIQUES	
CREDIT 3	**CLASS 45 HOURS**	**MARKS 50**
Module 1: Microscopy Simple Microscope; Compound Microscope; Phase-Contrast Microscope; Transmission Electron Microscope; Scanning Electron Microscope; Fluorescent Microscope; Microphotography; Micrometry		
Module 2: Chromatography Chromatographic techniques- Paper Chromatography, Thin layer chromatography and Ion exchange chromatography.		
Module 3: Electrophoresis and Centrifugation Principle of electrophoresis; Types of gel electrophoresis, SDS-PAGE. Centrifugation - Types of centrifugation – differential and density gradient.		
Module 4: Histology Histochemical and histological preparation of fish tissue; Fixation and fixatives; Temporary and Whole mount; Specimen preparation for TEM and SEM.		
REFERENCES		
1. Hofmann A and Clokie S. 2018. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press. 2. Swargiary A. 2017. Biological Tools and Techniques. Kalyani Publishers, New Delhi. 3. Mescher A. 2018. Junqueira's Basic Histology: Text and Atlas. McGraw-Hill Education. 4. Cui D. 2010. Atlas of Histology with Functional and Clinical Correlations. Lippincott Williams and Wilkins.		

DISCIPLINE SPECIFIC COURSE PRACTICAL (FSCDSC804P)	TOOLS AND TECHNIQUES (LAB)	
CREDIT 2	**CLASS 60 HOURS**	**MARKS 50**
1. Microtomy and staining of fish tissue- Liver, Kidney, Ovary, Testes, Stomach and Intestine. 2. Electrophoresis/paper chromatography (Demonstration). 3. Centrifuge (Demonstration)		

COURSE OUTCOME
TOOLS AND TECHNIQUES (FSCDSC804T)
Students will gather knowledge on different types of microscope, chromatography, electrophoresis and centrifugation and their functional principles; histochemical and histological techniques etc.
TOOLS AND TECHNIQUES (FSCDSC804P)
Students will gather hands on training on microtomy and preparation and staining of histological slides. They will also get practical knowledge on how to run paper chromatography and centrifuge.

HONOURS WITH RESEARCH (FSCHONR08D)
CREDIT 15