



UNIVERSITY OF CALCUTTA

Notification No. CSR/09/2026

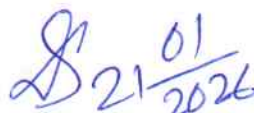
It is notified for information of all concerned that in terms of the provisions of Section 54 of the Calcutta University Act, 1979, (as amended), and, in the exercise of his powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 09.01.2026, approved the new revised Syllabus of Industrial Fish & Fisheries (IIFV, Core Vocational subject) including Question Patterns.

The above shall take effect from the Odd semester examinations, 2025 and onwards.

SENATE HOUSE

Kolkata-700073

21.01.2026


Prof.(Dr.) Debasis Das

Registrar

Outline Structure of NEP Curriculum for Industrial Fish and Fisheries, C.U.

PART I; SEM I

SUBJECT CODE	COURSE	NAME OF PAPER	THEORY	PRACTICAL
DSCC 1	VIFM	Fish Taxonomy	75	25
SEC-1	VIFM	Crab & pearl culture	75	25

PART I; SEM II

SUBJECT CODE	COURSE	NAME OF PAPER	THEORY	PRACTICAL
DSCC 2	VIFM	Freshwater aquaculture	75	25
SEC-2	VIFM	Ornamental fish production & management	75	25

PART II; SEM III

SUBJECT CODE	COURSE	NAME OF PAPER	THEORY	PRACTICAL
DSCC 3	VIFM	Fish Biology	75	25
DSCC 4	VIFM	Capture fisheries	75	25
SEC-3	VIFM	Brackish water aquaculture & mariculture	75	25

PART II; SEM IV

SUBJECT CODE	COURSE	NAME OF PAPER	THEORY	PRACTICAL
DSCC 5	VIFM	Aquatic ecology	75	25
DSCC 6	VIFM	Fish seed production technology	75	25
DSCC 7	VIFM	Fish genetic engineering & molecular biology	75	25
DSCC 8	VIFM	Fish nutrition & feed technology	75	25

PART III; SEM V

SUBJECT CODE	COURSE	NAME OF PAPER	THEORY	PRACTICAL
DSCC 9	VIFM	Fishing craft & gear technology	75	25
DSCC 10	VIFM	Fish pathology & immunology	75	25
DSCC 11	VIFM	Fundamental of microbiology	75	25
DSCC 12	VIFM	Fisheries economics & entrepreneurship development	75	25

PART III; SEM VI

SUBJECT CODE	COURSE	NAME OF PAPER	THEORY	PRACTICAL
DSCC 13	VIFM	Fisheries post-harvest technology	75	25
DSCC 14	VIFM	Fundamental of Biochemistry	75	25
DSCC 15	VIFM	Research Methodology 1	75	25
CU SUMMER INTERNSHIP		As per CU instruction	75(3 Credits)	

PART IV; SEM VII

SUBJECT CODE	COURSE	NAME OF PAPER	THEORY	PRACTICAL
DSCC 16	VIFM	Research Methodology 2	75	25
INTERNSHIP	VIFM	To be done from any institute or industries or farm related with fisheries (12 week)	400 (16 credits)	

PART IV; SEM VIII

SUBJECT CODE	COURSE	NAME OF PAPER	THEORY	PRACTICAL
PROJECT WORK	VIFM	Individual based project	500(20 credits)	

PART-I: SEMESTER- I

Core course

DSCC 1	FISH TAXONOMY (Theory)	
	Credit: 3; Marks: 75; Hours: 50	Hours
Unit 1: Systematics: Definition, component, importance.		2
Unit 2: Taxonomy: Definition, component, importance, micro & macro taxonomy, stages of taxonomy, Zoological Nomenclature: Requisites, ICZN, type concept. Molecular taxonomy- concept and application of genomics and proteomics in taxonomy, DNA barcoding.		8
Unit 3: Concept of Classification: Definition. Approaches in classification- Phenetics: Concept, phenograms; Cladistics: Concept, homology, homoplasy, cladograms; Evolutionary: Concept of monophyly, paraphyly & polyphyly; Component of classification: category, taxon. Linnaean hierarchy. Five kingdom concept of Whittaker, 1969.		18
Unit 4: Sub-phylum Crustacea: General characteristics and classification up to sub-classes with example (Ruppert and Barnes, 1994, 6th Ed.)		2
Unit 5: Phylum Mollusca: General characteristics and classification up to sub-classes (Ruppert and Barnes, 1994, 6th Ed.)		2
Unit 6: Class Chondrichthyes and actinopterygii: General characteristics and classification up to order with example (Nelson, 2010)		4
Unit 7: Species concept: Mechanism, merits and demerits of Biological, typological & Evolutionary species concept. Subspecies, Polytypic species, Sibling species and Ring species		4
Unit 8: Speciation: Modes of speciation – Sympatric, Allopatric and Parapatric, Isolation and its role in speciation (pre mating and post mating)		4
Unit 9: Origin & Evolution of fishes: Geological time scale, Origin & evolution of Chondrichthys, actinopterygii, Sarcopterygii (coelacanth & dipnoi).		6
DSCC 1-P: FISH TAXONOMY LAB (Practical)		
Credit: 1; Marks: 25; Hours: 50;		

1. Identification (with reasons) of locally available freshwater fish: *Labeo*, *Gibelion*, *Cirrhinus*, *Cyprinus*, *Hypophthalmichthys*, *Ctenopharyngodon*, *Puntius*, *Heteropneustes*, *Clarias*, *Mystus*, *Ompok*, *Wallago*, *Anabas*, *Notopterus*, *Pangasius*, *Rita*, *Channa* etc
2. Identification (with reasons) of locally available brackish water fish: *Mugil*, *Liza*, *Eleutheronema*, *Daysceiana*, *Lates* etc.

3. Identification (with reasons) of locally available marine water fish: *Scoliodon*, *Scyliorhinus*, *Sphyrna*, *Torpedo*, *Rhonobatos*, *Dasyatis*, *Pristis*, *Sardinella*, *Harpadon*, *Hilsa*, *Rastrelliger*, *Thunnus*, *Pampus* etc.
4. Identification (with reasons) of crustacea (prawns, brachyuran crab) and mollusca (bivalves, cephalopods): *Penaeus*, *Macrobrachium*, *Scylla*, *Lamellidens*, *Sepia*, *Loligo*, *Octopus*.
5. Field study to any landing centre in India to identify the commercially important marine fin fish and shellfish.
6. Laboratory Note Book.
7. Viva voce

Suggested readings:

- Kapoor V.C. (2017) Theory and Practical of Animal Taxonomy diversity. Oxford & IBH Publishing Co. Pvt. Ltd.
- Simpson G.G.(2012). Principles of Animal Taxonomy. Scientific publishers (India).
- Jayaram K.C(2010). Fish Taxonomy. NPH
- Jayaram K.C(2010). Fishes of the Indian region. NPH
- Nelson J.S.(2010). Fishes of the world.
- Ruppert E.E & Barnes R.D.(1994). Invertebrate Zoology.

Skill enhancement course

SEC 1 CRAB & PEARL CULTURE (Theory)	
Credit: 3; Marks: 75; Hours: 50;	
	Hours
Unit 1: Introduction: Present status of crab& pearl culture in India. Prospect and problem of crab and pearl culture in West Bengal.	04
Unit 2: Biology of Crabs: Morphology (external and internal), Sexual dimorphism, Reproductive biology & Life cycle, Habit (living, feeding, breeding)& Habitat of brachyuran crab (freshwater and brackish water). Ecological importance of crabs.	08
Unit 3: Crab culture: Cultivable species of crabs in India. Seed production techniques of mud crabs, crab hatchery, seed transportation & larval rearing. Different culture practices- Grow-out system, Crabs fattening (procedure, biochemical events), harvesting & marketing.	08
Unit 4: Biology of Pearl oyster: Cultivable species of pearl oyster in India. Morphology (external and internal), habit and habitat, and life cycle of pearl oyster.	08
Unit 5: Anatomy of Pearl oyster: Histology of mantle. Natural Process of Pearl formation. Chemical composition of Pearls. Economic importance of pearls.	06
Unit 6: Pearl oyster culture: Techniques of pearl oyster culture (Fresh water and Marine water) for artificial production of pearls- 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	16

insertion, Conditioning for surgery), Post-operative culture, harvesting and clearing of pearl.

SEC 1-P: CRAB & PEARL CULTURE LAB (PRACTICAL)

Credit: 1; Marks: 25; Hours: 50;

1. Identification (with reasons) of Pearl oyster.
2. Identification (with reasons) of freshwater and brackish water crabs.
3. Preparation of graft tissue, nuclei & surgical implantation in freshwater mussel.
4. Visit to a crab /pearl culture unit
5. Laboratory Note Book.
6. Viva voce

Suggested readings:

- Mcvey JP. 1983. Handbook of Mariculture. CRC Press.
- Pillay TVR & Kutty MN. 2005. Aquaculture- Principles and Practices. Blackwell.
- Thomas PC, Rath SC & Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ.
- Southgate P. and Lucas J. 2008. The Pearl Oyster 1st Edition. Elsevier Science

PART-I: SEMESTER- II

Core course

DSCC 2	FRESHWATER AQUACULTURE (Theory)	Hours
Credit: 3; Marks: 75; Hours: 50		
Unit 1: Scope and present status of aquaculture:	Selection of site, general planning and design of fresh water fish farms- quality and productivity of water, soil characteristics and other parameters.	06
Unit 2: Carp Culture:	Pre-stocking, Stocking and Post stocking management of Nursery, Rearing and Stocking pond.	08
Unit 3: Different systems of aquaculture:	Monoculture, Polyculture, Integrated fish farming, cage culture, pen culture, raft culture, extensive, semi intensive and intensive fish culture, raceway culture, culture in re-circulatory systems-Criteria for selection of species for culture.	08
Unit 4: Aquaculture diversification-	Aquaponics system, Biofloc culture, IMTA and Periphyton culture.	08

Unit 5: Sewage fed fish culture: Selection of species, methods of culture, advantage and disadvantage.	06
Unit 6: Culture of Catfishes and Murrels: Culturable species of catfishes and murrels, Spawning and fry production and grow out.	06
Unit 7: Culture of Tilapias: Cultivable species of tilapia, Culture systems, Grow out and feeding.	04
Unit 8: Culture of coldwater fishes: Cultivable coldwater fishes, culture systems, Grow out and feeding.	04

DSCC 2-P: FRESHWATER AQUACULTURE LAB (Practical)

Credit: 1; Marks: 25; Hours:50;

1. Analysis of physicochemical water parameters (River/pond/lake water) by Standard Methods (APHA) : D.O, Free CO₂, Total alkalinity, Total Hardness, Salinity, Phosphorus, Nitrite.
2. Analysis of physicochemical water parameters (River/pond/lake water) by Standard Methods (APHA) : Phosphorus, Nitrite.
3. Spot identification of aquatic weed: Pistia, Salvinia, Lemna, Chara, Eichhornia, Hydrilla, Ceratophyllum.
4. Spot identification of aquatic insect: Notonecta, Ranatra, Cybister, Lithocerus
5. Training on freshwater aquaculture.
6. Submission of Laboratory Note Book.
7. Viva voce

Suggested readings:

- Pillay T.V.R. and Kutty M.N. Aquaculture: Principles and Management. Willey India Pvt. Ltd
- Bardach J.E. Aquaculture. Willey
- Badapanda K.C. Aquaculture. Willey

Skill enhancement course

SEC 2	ORNAMENTAL FISH PRODUCTION & MANAGEMENT(Theory)	Hours
Credit: 3; Marks: 75; Hours: 50		

Unit 1: Basics of aquarium: Inception of the concept of aquarium; Different types and designs of aquarium: Design and construction of home and public aquaria (freshwater and marine), oceanarium. Aquarium accessories - aerator, diffuser, filters, lighting, thermostat and thermometer, feeding cup and feeding cone, light, internal and external decors.	4
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Unit 2: Aquarium Management: Setting up of aquarium (selection of site, selection of fish, selection of substrate and filters, temperature acclimatization, quarantine measures), plants, selection of fishes, Quarantine measures. Aquarium maintenance and water quality management. Control of snail and algal growth. Handling, care, packing and transportation of fishes - Use of anesthetics. Temperature acclimation.	6
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Unit 3: Freshwater Ornamental Fishes: Indigenous and exotic ornamental fishes in West Bengal. Biology (maturation, secondary sexual characters, breeding habits, spawning, parental care, fertilization and development of eggs) of Gold fish, Gourami, Barbs and Tetras, Angel fish, Cichlids.	12
Unit 4: Freshwater aquarium plants: Common aquarium plants, morphology and multiplication.	4
Unit 5: Ornamental fish Breeding: Hatchery management, breeding & larval rearing of live bearer (Guppies, Mollies, Sword tail and Platy), egg layers- (Gold fish, Angel fish, Zebra fish and Neon tetra) fishes.	6
Unit 6: Commercial Production: Requirements and design for the commercial production of ornamental fishes: Goldfish, live bearers, gouramies, barbs and tetras, angel fish. Natural ponds for the mass production of ornamental fishes. Mass production of aquarium plants.	8
Unit7: Ornamental fish feed and feeding management: Introduction of aquarium feeds. Live food organisms and their culture. Feeding methods and frequency. Formulation of artificial feeds	4
Unit 8: Common aquarium fish diseases and control measures: Some common diseases of ornamental diseases – pathogens, symptoms and control. Health management in Ornamental Fish Farming.	2
Unit 9: Ornamental fish trade, its regulations and wildlife act: Indian scenario, supply and demand situation. Trade regulations and acts. CITES, Prohibition of fish hunting.	4

SEC 2-P: ORNAMENTAL FISH PRODUCTION & MANAGEMENT LAB (Practical)

Credit: 1; Marks: 25; Hours: 50

1. Construction of a glass aquarium.
2. Setting up and maintenance of aquarium accessories and equipment
3. Identification of common aquarium fish: Gold fish, Betta, Gourami, Swordtail, Platy, Molly, Tetra, Barbs, Angelfish, Danio, Discus.
4. Identification of common aquarium plants: Vallisneria, Cabomba, Echinodorus, Duckweed, Ceratophyllum.
5. Visit to any ornamental fish farm in West Bengal.
6. Laboratory Note Book.
7. Viva voce

Suggested readings:

- Saxena A. Aquarium Management.
- Hunnam P., Milne A., Stebbing P. The living aquarium.
- CIFE. 1993. Training Manual on Culture of Live Food Organisms for AQUA Hatcheries. Central Institute of Fisheries Education, Versova, Mumbai.
- Paulraj R. 1997. Aquaculture Feed: Handbook on Aquafarming. MPEDA Publ.

PART-II: SEMESTER- III

Core course

DSCC 3	FISH BIOLOGY (Theory)	Hours
Credit: 3; Marks: 75; Hours: 50;		
Unit 1: External morphology of fish: Structure, function and comparative account of integument, scales, mouth and fin.		2
Unit 2: External morphology of shell fishes: Prawn, Crab, Lobster, Bivalves, Gastropods and Cephalopod.		4
Unit 3: Internal anatomy of fish: Skeletal system- jaw suspension, Structure of branchial & visceral arches in fishes, Digestive system- comparative account of gastro-intestinal tract in herbivorous & carnivorous fishes, Circulatory system- comparative account of heart & aortic arches in teleost & dipnoi fishes, Respiratory system- respiratory & accessory respiratory organs in fishes, Excretory organ-kidney & its unit, Sense organ-eyes and photoreception, lateral line system, neuromast organ, ampullae of Lorenzini, pit organs.		16
Unit 4: Internal anatomy of Prawn: Structure of Digestive system, Respiratory system, Circulatory system, excretory system, reproductive and endocrine system.		10
Unit 5: Fish Physiology: Osmoregulation in fish. Endocrine organs in fishes and their roles in control of reproduction in fishes. Physiology of digestion, respiration (aquatic and aerial) and vision. Bioluminescence in fishes. Physiology of electric organs in fishes. Gametogenesis and fertilization of fishes. Poisonous and venomous fish.		10
Unit 6: Fish Age & Growth: Different food and feeding habit of fishes. Isometric and allometric growth, analysis of age/growth by hard parts (Scale, otolith, vertebrae), Marking and tagging of fish for growth studies, length-weight relationship, ponderal index, the cube law, relative condition factor, gastrosomatic index (GaSI) and gonadosomatic index (GSI).		5
Unit 7: Fish migration: Purpose and types of migration in fish, diadromous migration, physiological factors controlling iono- and osmoregulation, energetics, environmental factors, anthropogenic impacts.		2
Unit 8: Parental care in fish: Different types of parental care in fish.		1

DSCC 3-P: FISH BIOLOGY LAB (Practical)

Credit: 1; Marks: 25; Hours: 50;

1. Major Dissection:

- (i) Urinogenital system of Tilapia/Mrigal.
- (ii) Weberian ossicles of Carp (Rohu/Mrigal).
- (iii) Afferent and efferent branchial system in Lata.

2. Minor Dissection:

- (i) Digestive system of Mrigal.
- (ii) Mounting of appendages of Prawn/Shrimp/crab.
- (iii) Mounting of the different types of scales (placoid, cycloid, ctenoid) of fishes.
- (iv) Otolith of Tilapia.
- (v) Accessory Respiratory organs of singi, magur, and koi.
- (vi) Pharyngeal teeth of carp

3. RLG, Gut content analysis of Tilapia, Mrigal.

4. Laboratory Note Book.

5. Viva voce

Suggested readings:

- Ganguly B.A., Sinha A.K., Adhikari S., Goswami B.C.B. (2018). Biology of Animals (Vol I & II). NCBA
- Khanna S.S. (2014). Introduction to Fishes. Silver Line
- Srivastava C.B.L. (2014). Fishery Science and Indian Fisheries.
- Reinecke, 2006. *Fish Endocrinology*, Vol. 2: Enfield "Science Publishers, Inc.: "xx, 441-871pp" ISBN: 978-1-57808-415-9 Jayaram K.C. (2010). Fishes of the Indian region. NPH
- Nelson J.S. (2010). Fishes of the world.
- Ruppert E.E. & Barnes R.D. (1994). Invertebrate Zoology.

Core course

DSCC 4	CAPTURE FISHERIES (Theory)	Hours
Credit: 3; Marks: 75; Hours: 50		
Unit 1: Riverine fisheries:	Major river system in India with special emphasis on morphometrics, characteristic ichthyofauna and threat. Prospect, problem and development of riverine fisheries in India. Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes.	8
Unit 2: Cold water 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. Present status, Prospect, Problems and development of cold water fisheries in India.	8
Unit 3: Reservoir and Lacustrine fisheries:	Definition and ecological features of reservoirs and lakes. Major reservoirs and lakes in India with emphasis on capture fisheries. Development of reservoir fisheries in India. Morphometrics of reservoirs and lake.	18
Unit 4: Estuarine fisheries:	Definition and classification of estuaries, capture fisheries-resident and migrant species. Fisheries of brackish water lake and backwaters. Problem of brackish water fishery in India.	12
Unit 5: Marine fishery resources in India:	Marine capture fishery resources at inshore, offshore and deep sea. EEZ, PFZ and continental shelf, maritime states in India. Biology and fisheries of Oil sardine, Hilsa, Pomfret, Bombayduck, Mackerel, ribbon fish, sole fish, eel, catfishes, prawns, lobsters, mollusks.	10

DSCC 4-P: CAPTURE FISHERIES LAB (Practical)

Credit: 1; Marks: 25; Hours: 50;

1. Analysis of species composition in any landing centre by Line diagram, Bar diagram, Pie diagram & Histograms in relation to abundance and catch particular of fish.

2. Laboratory Note Book.

3. Viva voce

Suggested readings:

- Bal DV and Rao KV. 1990. Marine Fishes of India. 1st Revised Ed. Tata McGraw Hill.
- Blaber JM. 1997. Fish and Fisheries in Tropical Estuaries Chapman and Hall.
- FAO. Technical Papers on Freshwater Fisheries.
- Jhingran VG. 1991. Fish and Fisheries of India. 3rd Ed. Hindustan Publ.

Skill enhancement course

SEC 3 BRACKISHWATER AQUACULTURE & MARICULTURE (Theory)

Credit: 3; Marks: 75; Hours: 50

Hours

Unit 1: Introduction: An overview of sea farming and shore-based aquaculture in different parts of the world. Present status&resources for shore-based aquaculture and sea farming in India. Physicochemical parameters of brackish water. Selection of site, general planning and design of brackish water fish farms.Tide fed, pump fed farms.

4

Unit 2: Mariculture (Open sea farming): Scope and species cultured. Selection of site for sea farming. Different designs of open sea farming structures – construction of cages, rafts, racks, poles & ropes – bioengineering problems and solutions.Shore based aquaculture system: traditional (pokkali, bheries), semi- intensive, intensive aquaculture practice of commercially important species of fish and shellfish.

6

Unit 3: Brackish water Finfish Culture: Cultivable species- Seabass, mullet, milkfish, grouper, cobia, snappers, pearlspot culture in brackish water systems. Culture system– monoculture and polyculture. Management of Brackish water fish pond, cages and pens- Nursery, rearing and grow out.

12

Unit 4: Culture of Mollusca, Echinoderms: Present status and future prospects in India.Molluscan culture- edible oysters, mussels and clams, Echinoderms culture-distribution, practices followed in India and other Asian countries, farming methods–different types and culture methods; Problems.

4

Unit 5: Seaweed farming: Major seaweed species of commercial importance; tissue culture of seaweeds, methods of culture; farming of agar, algin and carragenan yielding species; emerging

6

trends in their farming in open seas; Integration with other coastal and marine farming systems.	
Unit 6: Environmental Impacts of brackish water aquaculture: Environmental impact of brackish water and coastal aquaculture - Salinity intrusion, effluent discharge, eutrophication, chemical residues including antibiotics and hormones, destruction of natural habitat including paddy field and mangroves. Social issues and conflicts with other users on resources.	8

SEC 3-P: BRACKISHWATER AQUACULTURE & MARICULTURE LAB (Practical)
Credit: 1; Marks: 25; Hours: 50;

1. Analysis of Soil parameters: Determination of pH, available nitrogen, phosphorus and organic Carbon.
2. Visit to any brackish water fish farm.
3. Laboratory Note Book.
4. Viva voce

Suggested readings:

- Pillay T.V.R. and Kutty M.N. Aquaculture: Principles and Management. Willey India Pvt. Ltd
- Bardach J.E. Aquaculture. Willey
- Badapanda K.C. Aquaculture. Willey
- Thomas P.C. Breeding and seed production of fin fish and shellfish. Daya publishing house.

PART-II: SEMESTER- IV

Core course

DSCC 5	AQUATIC ECOLOGY (Theory)	Hours
	Credit: 3; Marks: 75; Hours: 50	
Unit 1: Introduction: Definition of Ecology and Ecosystem, Subdivision of ecology- autecology and synecology.		2
Unit 2: Species and the individual in the ecosystem: Concept of habitat and ecological niche, ecological equivalents, character displacements- sympatry and allopatry, Biological clocks.		8
Unit 3: Population (Structure and dynamics): Population characteristics, theories of population growth, population interactions.		6
Unit 4: Community (Structure, classification and dynamics): Characteristics of community- species diversity, growth forms and structure, dominance, composition, structure. Ecological succession- definition, types of succession, general process of succession, hydrochere.		8
Unit 5: Ecosystem(Structure and function): Definition, kinds of ecosystem, structure of ecosystem, ecological pyramids, productivity, food chains, food webs, energy flow in ecosystem, pond ecosystem, ocean(marine) ecosystem.		6

Unit 6: Fresh water ecology: The freshwater environment, types and limiting factor, ecological classification of freshwater organism, the freshwater biota, lentic communities, lakes, ponds, lotic communities, longitudinal Zonation in streams, springs.	6
Unit 7: Marine ecology: The marine environment, the marine biota, Zonation in the sea, communities of the marine environment.	4
Unit 8: Estuarine ecology: Definition and types, biota and productivity.	2
Unit 9: Water pollution: Sources of water pollution, Ground water pollution, marine pollution, mercury pollution, fluoride pollution, Ganga action plan(GAP), Yamuna action plan(YAP), Prevention and control of water pollution, wetland conservation.	8

DSCC5-P: AQUATIC ECOLOGY LAB (Practical)

Credit: 1; Marks:25; Hours: 50

1. Estimation of BOD and COD from any water body
2. Estimation of productivity in water bodies.
3. Collection, fixation and Identification of living phytoplankton and zooplankton from the water bodies.
4. Identification of phyto-and zooplankton using permanent slide.
5. Laboratory Note Book.
6. Viva voce

Suggested readings:

- E.P. Odum (1971) Fundamental of Ecology. W.B Sounders,
- Sharma P.D.- Ecology And Environment. Rastogi Publications

Core course

DSCC 6 FISH SEED PRODUCTION TECHNOLOGY (Theory)

Credit: 3; Marks: 75; Hours: 50

Hours

Unit 1: Endocrine aspect of fish reproduction: Control of fish reproduction by brain peptide, regulation of gonadal function by pituitary gonadotropin, endocrine control of gonadal development and maturation by steroid hormones, Histology of Pituitary, Testis and Ovary. Hormonal regulation of spermatogenesis and oogenesis. Environmental regulation of reproduction.	5
Unit 2: Broodstock management: Factors affecting the maturation and spawning of cultivable fishes, Nutritional and environmental requirement for brood stock. Criteria for the selection of brood stock, selective breeding strategies, Transportation of broodstock, use of anesthetics and therapeutics for health management of brood stock.	8
Unit 3: Induced Breeding of Fishes: History of induced breeding of fishes, Methods of pituitary extract preparation, dosage determination, and injection to the brood fishes, spawning and hatching. Use of different synthetic hormones and analogues for induced spawning. Stripping and fertilization.	12

Unit 4: Hatchery Technology & freshwater fish seed production: Bundh breeding, types of bundh breeding techniques and problems of bundh breeding. Design and function of different hatchery system-incubators, glass jar hatchery, Chinese circular hatchery and other hatchery systems. Seed production of Indian Major Carps, Mahaseer and Trout using hatchery.	11
Unit 5: Marine fish seed production: Sea bass, milkfish, mullets, Cobia and Silver pompano.	10
Unit 6: Seed production in shell fishes: Hormonal control of reproduction. Developmental stages. Seed production and nursery rearing of <i>Penaeus monodon</i> and <i>Macrobrachium rosenbergii</i> . Various components, equipments and infrastructures facilities required.	3
Unit 7: Collection of fish seed from natural resources: Riverine seed production techniques, different stages of seed: spawn, fry and fingerlings.	1

DSCC6-P: FISH SEED PRODUCTION TECHNOLOGY LAB (Practical)

Credit: 1; Marks:25; Hours: 50;

1. Tissue fixation, embedding in paraffin, sectioning and slide preparation from testis and ovary of fish.
2. H-E staining of Histological slides
3. Dissection and collection of fish pituitary gland, preservation, extract preparation, doses Determination and injection to the brood fishes.
4. Visit to any Govt. / Pvt. Hatchery farm (Fresh water fish/Brackish water fish/Aquarium fish/Prawns)
5. Laboratory Note Book
6. Viva voce

Suggested readings:

- Jhingran VG & Pullin RSV. 1985. Hatchery Manual for the Common, Chinese and Indian Major Carps. ICLARM, Philippines.
- Jhingran VG. 1991. Fish and Fisheries of India. Hindustan Publ.
- Rath RK. 2000. Freshwater Aquaculture. Scientific Publ.
- Thomas PC, Rath SC & Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ.

Core course

DSCC 7	FISH GENETIC ENGINEERING & MOLECULAR BIOLOGY(Theory)	Hours
Credit: 3; Marks: 75; Hours: 50		
Unit 1: Nucleic acids: Chemical composition of DNA and RNA; Watson and Crick Model of DNA, Secondary structure (Cloverleaf model) of tRNA. Griffith's experiment: DNA as genetic material		3
Unit 2: DNA Replication: Enzymes of DNA replication, Mechanism of DNA replication in Prokaryotes, prove that replication is semi-conservative. Fidelity of DNA replication.		3

Unit 3:Transcription: Mechanism of Transcription in prokaryotes. transcription factors, difference between prokaryotes and eukaryotic transcription.	2
Unit 4: Translation: Mechanism of translation in Prokaryotes. Genetic code, Degeneracy of the genetic code, wobble hypothesis, inhibitors of protein synthesis, difference between prokaryotic and eukaryotic translation.	4
Unit 5: Post Transcriptional modifications and processing of eukaryotic RNA: Capping, splicing and polyadenylation.	3
Unit 6: DNA Repair mechanism: Types of DNA repair mechanisms, RecBCD model in prokaryotes, nucleotide and base excision repair, SOS repair.	3
Unit 7: Molecular techniques: PCR, Western, Southern and Northern Blot, Sanger DNA sequencing.	3
Unit 8: Gene structure and Function: Gene complementation, Cistron, muton, recon,molecular recombination, gene regulation, Operon concept- lac operon.	6
Unit 9: Principle of Genetic Genetic Engineering: Isolation of DNA and RNA, Recombinant DNA Technology, Cloning, Plasmids, Cosmids, Bacteriophages, Transformation and Transduction. Construction of genomic and cDNA library.	6
Unit 10: Molecular hybridization: Labelling of Nucleic acid, molecular markers, amplification of DNA, Blotting techniques- Southern, Northern and Western blotting, DNA sequencing.	8
Unit 11: Chromosomal types and composition in fish. Chromosomal manipulation in fish, Hybridization. Polyploidy, androgenesis and gynogenesis.	3
Unit 12: Transgenic fish production. Cryopreservation of gametes. Production of monosex and sterile fishes and their significance in aquaculture.	6

**DSCC7-P: FISH GENETIC ENGINEERING & MOLECULAR BIOLOGY LAB
(Practical)**

Credit: 1; Marks:25; Hours: 50;

1. Estimation of DNA by diphenylamine method.
2. DNA isolation from fish liver.
3. Differential centrifugation of an artificially prepared mixture.
4. Histological staining of DNA & RNA in prepared slide.
5. Viva voce

Suggested readings:

- Russel P.J. iGenetics : A molecular approach.
- Allison LA. 2007. Fundamental of Molecular Biology. Blackwell Publishing. W.H.Freeman
- Lodish, B, Matsudaira, KB, Plough, A, and Martin, 2016. Molecular Cell Biology. W.H.Freeman
- Cooper GM, Hausman RE, 2009. The Cell: A molecular approach. ASM

DSCC 8 FISH NUTRITION & FEED TECHNOLOGY (Theory)		
Credit: 3; Marks: 75; Hours: 50		Hours
Unit 1: Fundamental of aquaculture nutrition: Sources and importance of major nutrients (proteins, fats, carbohydrate, vitamins and minerals) for cultivable fin fish and shell fish.		2
Unit 2: Natural fish feed organism: Diversity, management and importance of natural fish feed organisms- algae, protozoa, crustaceans and annelids.		8
Unit 3: Feed formulation: Method of feed formulation and manufacturing- Pearson's methods, quadratic, linear programming; Forms of aqua feed- wet feeds, moist feed, dry feed, masses, pelleted feed, floating and sinking pellets; Common equipments-pulverizer, grinder, mixer, pelletizer, crumbler, drier, extruder, vacuum coater, fat sprayer; Proximate composition of fish feed.		12
Unit 4: Feed additives: Dietary supplements, growth promoter, feed stimulants, binders, pigments, antioxidants, enzymes.		5
Unit 5: Feed ingredients: Utility and proximate composition of fish meal, soybean meal, ground nut oil cake, mustard oil cake, rice bran; Non-conventional feed ingredients.		5
Unit 6: Feed evaluation: Definition, measurement and significance of Feed Conversion Ratio (FCR), Feed Efficiency Ratio (FER), Protein Efficiency Ratio (PER), Net Protein Utilization (NPU), Specific Growth Rate(SGR), Weight Gain Percentage(WG%), Gross Energy(GE).		4
Unit 7: Non nutrient dietary component: Antinutritional factors, Digestive enzymes and their roles in digestion, Feed digestibility- Measurement of digestibility, Factors affecting digestibility.		2
Unit 8: Culture of live fish food organisms: Candidate species of phytoplankton and zoo-plankton as live food organisms of freshwater and marine species. Tropic potentials- proximate composition of live feed. Biology and culture requirements of important live food organisms. Green algae, blue-green algae, spirulina, diatoms, infusoria, rotifers, cladocerons, tubifex, brine shrimp, chironomids. Culture of earthworms.		12
DSCC8-P: FISH NUTRITION & FEED TECHNOLOGY LAB (Practical)		
Credit: 1; Marks:25; Hours: 50;		

1. Fish feed formulation and manufacturing using locally available materials
2. Proximate composition of fish feed (moisture/crude protein).
5. Estimation of digestive enzyme activity (intestinal amylase) in fish.
6. Visit to an aquafeed manufacturing industry.
7. Viva voce

Suggested readings:

- CIFE. 1993. Training Manual on Culture of Live Food Organisms for AQUA Hatcheries. Central Institute of Fisheries Education, Versova, Mumbai.
- Paulraj R. 1997. Aquaculture Feed: Handbook on Aquafarming. MPEDA Publ.
- De Silva, S. S. and Anderson, T. A. 1995. Fish Nutrition in Aquaculture. Chapman and Hall Aquaculture Series, London.
- Halver, J.E. 2002. Fish Nutrition. Academic Press, San Deigo, C.A.

PART-III: SEMESTER- V*Core course*

DSCC 9 FISHING CRAFT & GEAR TECHNOLOGY (Theory)	
Credit: 3; Marks: 75; Hours: 50;	
	Hours
Unit 1: Fishing crafts: Boat building material- wood, steel, aluminum, Ferro-cement, FRP (GRP)-advantages and disadvantages. 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.	12
Unit 2: Fishing gears: Classification of fishing gear (A. Von Brandt, Hameed and Boopendranath, 2000). Fishing gear materials- natural, synthetic materials, properties and preservation, yarn numbering systems, direction of netting, type of knots, meshes, fly meshing. Mounting and webbing- different methods, hanging co-efficient. Fishing gear accessories- floats, sinkers, otter board, hook and ropes. Operation, Classification and design description of trawling, purse seining, gill netting, line fishing and squid jigging. Traditional fishing gears of West Bengal. Catch per unit effort of fishing gear.	12
Unit 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, sonar, net sonde, gear monitoring equipments; remote sensing.	18
Unit 4: Responsible Fisheries and Fisheries Legislation: Concept of Responsible Fisheries; Monsoon trawl ban, closed season, mesh size regulations, juvenile fishing, Coastal Regulation Zone (CRZ), Integrated Coastal Zone Management (ICZM). MSY, MEY, Over fishing, Recruitment over fishing, Aqua-ranching.	8
DSCC9-P: FISHING CRAFT AND GEAR TECHNOLOGY LAB (Practical)	
Credit: 1; Marks: 25; Hours: 50;	

1. Common knot used in net making.
2. Net making by hand braiding
3. Mounting of fishing net.
4. Identification of traditional fishing crafts in India
5. Identification of fishing gears and accessories
6. Laboratory Note Book.
7. Viva voce

Suggested readings:

- Biswas K.P. Advancement in fish, fisheries and technology. Narendra Publishing House.
- Badapanda K.C. Fishing Crafts and Gear technology. Narendra Publishing House.
- Hameed M.S. and Boopendranath M.R., Modern Fishing Gear Technology. Daya publishing house Delhi (2000).

*Core course***DSCC 10 FISH PATHOLOGY & IMMUNOLOGY (Theory)****Credit: 3; Marks: 75; Hours: 50****Hours**

Unit 1: Fin Fish Pathology: Causative agents, symptoms and control of some infectious diseases of fish- Fungal Diseases(Saprolegniasis, Branchiomycosis), Bacterial Diseases(Fin and Tail rot, Ulcer diseases, Dropsy, Eye diseases, Ferunculosis, Bacterial Gill diseases, ERM, Edwardsiellosis, Vibriosis), Protozoan Diseases(White spot diseases, Costiasis, Trichodinosis, Whirling disease), Metazoans(Myxozoan, Dactylogyrus, Gyrodactylus, Hirudinea, Lernaea, Argulus).

10

Unit 2: Morphology, life cycle and control of fish pathogen: Myxozoan parasites, Dactylogyrus, Gyrodactylus, Hirudinea, Lernaea, Argulus. Viral diseases (IPN, IHN, VHs, CCVD), EUS.

9

Unit 3: Shell Fish Pathology: Some common diseases of prawns – pathogens, symptoms and control- IHN, Baculovirus, Black gill disease, brown spot disease.

6

Unit 4: Introduction of Immune system: Concept of health and disease, Cells and organs of immune system in fish.

4

Unit 5: Antigen: Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes

4

Unit 6: Immunoglobulin: Structure and function of different classes of immunoglobulins

2

Unit 7: Immunity: Innate and adaptive immunity. Humoral and Cell mediated immunity. Complement proteins – pathways and activation (classical, alternative and lectin mediated pathway, MAC formation

6

Unit 8: Major Histocompatibility Complex: Structure and functions of MHC molecules. Structure of T cell Receptor and its signalling, T cell development & selection, Antigen presentation.

5

Unit 9: Vaccine: Different types of vaccine, strategies of vaccine development - subunit vaccine, mRNA vaccine and others.

4

DSCC 10-P: FISH PATHOLOGY & IMMUNOLOGY LAB (Practical)**Credit: 1; Marks:25; Hours: 50;**

1. Identification of fish disease- gill rot, fin and tail rot, dropsy, EUS.
2. Collection and identification of crustacean parasites from carps.
3. Total count of RBC and WBC in fish using haemocytometer.
4. Differential count of WBC in fish.
5. Laboratory Note Book.

Suggested readings:

- Cornoy D.A, Herman R.A. Text book of fish diseases.
- Kindt T.J. and Osborne B.A., Kuby Immunology.

Core course

DSCC 11	FUNDAMENTAL OF MICROBIOLOGY (Theory)	Hours
Credit: 3; Marks: 75; Hours: 50		

Unit 1: Introduction: History and development of microbiology; Contributions of Louis Pasteur, Koch and Winogradsky –Diversity of microbial community – General characteristics of bacteria, fungi, viruses, algae and protozoans. .	2
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Unit 2: Structure of microbes: Structure of prokaryotic cell, Structure and function of bacterial cell wall, plasma membrane, capsule, flagella and endospore. Structure of fungi and yeast cell. Structure of virus. Classification of viruses. Life cycle bacteriophages - lytic and lysogenic cycle.	12
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Unit 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 cultivation of bacteria and fungi from water and sediment. Different culture techniques.	18
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Unit 4: Aquatic Microbiology: Microflora of aquatic environment. Autotrophic and heterotrophic microorganisms in aquatic environment. Nutrient regeneration, role of microbes in biogeochemical cycles – Carbon, Nitrogen, Phosphorus and Sulphur cycles. Autochthonous and allochthonous microorganisms in aquatic environment.	5
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Unit 5: Bacteria in culture pond: Health significant bacteria in culture ponds. Culture characteristics and epidemiology of <i>E. coli</i> , pathogenic <i>Vibrio</i> , <i>Salmonella</i> , <i>Aeromonashydrophila</i> , and <i>Pseudomonas</i> .	2
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Unit 6: 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.	7
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Unit 7: Bacterial genetics: Transformation, Conjugation and Transformation in bacteria	4
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DSCC11-P: FUNDAMENTAL OF MICROBIOLOGY LAB (Practical)

Credit: 1; Marks: 25; Hours: 50;

1. Sterilization technique- dry heating, autoclaving
2. Media preparation: Liquid media (broth), solid media
3. Gram staining of bacteria.
4. Biochemical tests for characterization: Catalase, nitrate reduction, indole production, methyl red and Voges–Proskauer test
5. Laboratory Note Book.
6. Viva voce

Suggested readings:

- Fernandes R. Microbiology Handbook: Fish and Seafood. Leatherhead Food Research Association; 2nd New edition edition.
- Harry W. Seeley, Paul J. Vandemark, and John J. Lee- Microbes in Action: A Laboratory Manual of Microbiology. W. H. Freeman
- Pawar and Diganawala- General Microbiology – Vol. I and Vol. II
- Frobisher et al- Fundamentals of Microbiology

Core course

DSCC 12 FISHERIES ECONOMICS & ENTREPRENEURSHIP DEVELOPMENT (Theory)	
Credit: 3; Marks: 75; Hours: 50	
	Hours
Unit 1: Principles of economics: Definition, subject matter and scope of economics. Law of diminishing returns, laws of increasing, constant and decreasing utility and returns. Importance of economics in aquaculture development	2
Unit 2: Economy of fishermen: Fishermen populations, GDP from fisheries sector, foreign exchange earnings and employment potential of fishing industry. Role of MPEDA in exports of fish and fishery products.	4
Unit 3: Prospective of Aquaculture in Socio-Economic impact & Rural Development: Resource use and development, Socio-economic analysis, Socio-demographic profile, work contribution, household expenditure, income contribution, decision making, female headed household, impact of different age groups, socio-economic condition of fisherman.	10
Unit 4: Fishery co-operatives & Extension: Functions, financial assistance, input supplies, marketing of fish. Socio-economic development. Role of fisheries corporations and Missionary Organizations in fisheries development. Extension education- objective and principles. Role of extension in community development. Integrated rural development strategies.	4

Unit 5: Entrepreneurship Building: Meaning, Importance, Psychological, Sociological factors and distinctive competence. Need, scope, characteristics and types of Entrepreneurship. STED. Human resource management, Leadership, Motivation attitude, communication, Group dynamics, Delegation, Setting of goals, Transactional analysis, Creativity, Problem solving, Strength weakness opportunity and threat (SWOT) Techniques, Decision making, Stress management.	8
Unit 6: Market & Marketing Management : 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. Marketing management- Elements of marketing & sales management. Nature of product and market strategy – Packing & advertising – After sales service. Analyzing marketing opportunities, Planning marketing strategy, Forecasting, Marketing mix, Advertising the marketing programme & sales management, market survey techniques.	8
Unit 7: Technology Management: Criteria for principles of product, selection and development. Choice of technology, plant and equipment. Critical Path Method (CPM) & Project Evaluation Review Techniques (PERT) as planning tools for establishing SSI. Production Management- Elements of production process, Planning and control, Product development, Testing facilities, Patents, Quality Assurance, Time control and Cost control, Total Quality Management. Materials Purchasing Management: Material Planning and Budgeting, Value engineering, Value analysis, Economic ordering quantity, Inventory control.	14

DSCC12-P: FISHERIES ECONOMICS & ENTREPRENEURSHIP DEVELOPMENT LAB (Practical)
Credit: 1; Marks:25; Hours: 50;

1. Submission of a report on fish market survey/socio-economic status of fishermen of any fishing villages in West Bengal.
3. Viva voce

Suggested readings:

- Saxena A. Fisheries Extension.
- Ry G.L. Extension, commercial and management. Naya Prakash Pawar and Diganawala- General Microbiology – Vol. I and Vol. II

PART-III: SEMESTER- VI

Core course

DSCC 13 FISHERIES POST HARVEST TECHNOLOGY (Theory) Credit: 3; Marks: 75; Hours: 50;		Hours
Unit 1: Post Harvest Technology: Principles and importance of fish preservation. Fish spoilage- post mortem changes and rigor mortis, post rigor spoilage. Methods of fish preservation- Freezing, Drying, Salting, Smoking, Canning, Fermentation and Fish Pickling.		12

Unit 2: Fish product and Byproduct: Fish Oil, Fish liver oil, Fish meal, Fish manure, Fish flour, fish glue and isinglass, traditional fermented fish products of northeast India.	6
Unit 3: Quality control: Basic concepts of quality and quality control; pre-shipment inspection, IPQC, MIPQC, HACCP and ISO Series in seafood industry.	8
Unit 4: Plant hygiene and sanitation: Principles of plant hygiene and sanitation, Pest control, Sanitation procedures in seafood processing plants. Waste management in fish processing industries. Risk factors in seafood bio toxins, seafood pathogens, endogenous parasites. Planning and layout, equipment construction and design.	8
Unit 5: Methods of evaluating fish freshness and quality: Organoleptic, physical, chemical, microbiological and instrumental methods.	6
Unit 6: Quality standards: Quality standard in India and major importing countries like USA, Japan and EU.	4
Unit 7: Export of fishery products from India: Major countries, important products, export documents and procedures. Traceability, Quality certifications, Eco-labelling.	6

DSCC13-P: FISHERIES POST HARVEST TECHNOLOGY LAB (Practical)

Credit: 1; Marks:25; Hours: 50;

1. Biochemical characterization of fish product (pH, TTA, moisture, crude protein)
2. Determination of anti-oxidative properties of any fish product using spectrophotometers.
3. Assessment of quality of fresh fish by sensory methods.
4. Laboratory Note Book.
5. Viva voce

Suggested readings:

- Biswas K.P. Fish Processing and Preservation. Daya Pub. House.
- Govindan T.K. Fish Processing Technology. Oxford & IBH Pub. Co.
- Badapanda K.C. Fish processing and preservation technology. Narendra Publishing House.

Core course

DSCC 14	FUNDAMENTAL OF BIOCHEMISTRY (Theory)	Hours
Credit: 3; Marks: 75; Hours: 50;		

Unit 1: Structure of carbohydrate: Monosaccharides-aldoses, ketoses, stereoisomers, epimers, anomers, mutarotation, reducing sugar; Disaccharides- maltose, lactose, sucrose; polysaccharides- starch, glycogen, cellulose, glycogen, chitin; proteoglycan, glycoprotein and glycolipid	6
Unit 2: Structure of amino acid and proteins: Peptide bond, Concept of Ramachandran plot, Primary, secondary, tertiary and quaternary structure of protein, classification of protein, structure and classification of amino acids.	4
Unit 3: Structure of fatty acids and lipid: Structure of saturated and unsaturated fatty acids, triacylglycerols, glycerophospholipids, sphingolipids and cholesterol, importance of ω 3 and ω	4

6 fatty acids.	
Unit 2: Carbohydrate metabolism: Process of Glycolysis, TCA cycles, Glycogenolysis, Glycogenesis, Gluconeogenesis. Inhibitors of TCA cycle. Pentose phosphate pathway or HMP shunt	8
Unit 3: Oxidative phosphorylation: Redox systems; Mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System	6
Unit 4: Lipid metabolism: Synthesis of a saturated fatty acid (Palmitic acid), Beta oxidation of a saturated (Palmitic acid) and an unsaturated fatty acid (Linoleic acid).	4
Unit 5: Protein Metabolism: Transamination, Deamination and urea cycle.	8
Unit 6: Enzymes: Classification, Kinetics (Michelis-Menten Concept), Factors affecting enzymatic action.	10

DSCC14-P: FUNDAMENTAL OF BIOCHEMISTRY LAB (Practical)
Credit: 1; Marks:25; Hours: 50;

1. Qualitative tests of functional groups in carbohydrates and proteins: Qualitative tests for carbohydrate (starch, sucrose, fructose, glucose), protein (albumin). Test to be performed- Molisch's test, Iodine test, Fehling's test, Benedict's test, Barfoed test, Seliwantof's test, Biuret test.
2. Quantitative estimation of water soluble protein following Lowry Methods.
3. Paper Chromatography of essential amino acids.
4. Laboratory Note Book.
5. Viva voce

Suggested readings:

- Das D. Biochemistry. Academic publishers.
- Nelson D.L.& Cox M.M. Lehninger Principles of Biochemistry. Mac Millan Worth Pub.
- Voet D & Voet J Biochemistry

Core course

DSCC 15	RESEARCH METHODOLOGY 1 (Theory)	Hours
Credit: 4; Marks: 75; Hours: 45		
Unit 1: Plan and Design of research framework: (Basic concept)Formulation of research problem, Types of investigation; Aim, Objective, Hypothesis; Items, Observation, Sample and types of sampling, Population, Treatment, variables, Test and controls, Replica, Repeatability, Questionnaires, Focus group, Determination of Sample size, Collection of data, Criteria of good research. Problems encountered by researchers in India.		7
Unit 2: Data: Type of Data :qualitative, quantitative, descriptive, discrete, continuous, rankable, nominal, ordinal, interval, derived variable. Distribution of Data (basic idea): Normal distribution, Binomial distribution, Poisson distribution, Exponential		7

distribution. Parametric and Non-parametric data.	
Unit 3: Estimate of the central tendency: Concept and calculation of mean, median and mode (only for normal distribution). Estimation of variance and standard distribution of normally distributed data.	5
Unit 4: Hypothesis testing: Types of hypothesis, sampling error, test statistics, P-value, one-tailed and two-tailed test, degree of freedom, chi-squared goodness of fit test, Student's t-test (matched and unmatched data).	10
Unit 5: Correlation and Regression: .Correlation co-efficient, Positive and negative correlation, co-variance, Linear regression and regression line, concept of outlier.	6
Unit 6: Research ethics: Basic codes for research ethics, Objective of research ethics, Emergence of concept of biomedical research ethics, Types of biomedical research (Basic, Preclinical, Clinical, translational), International guideline (WMA guideline Helsinki International, 1964) for biomedical research involving human subjects. ICMR guideline for biomedical research in India. Research ethics committee on human subject and its duty. Preclinical Research: Indian regulations of animal ethics, Animal ethics committee. Animal Welfare Board in India (AWBI) and its activity.	5
Unit 7: Biological Research and society: Societal perception on biomedical research, contemporary factors shaping societal perception, Public mistrust and strategies for trust building, science-society dialogue; Socio-economic, political, commercial aspect of biomedical research.	5
DSCC 15-P: RESEARCH METHODOLOGY 1 LAB (Practical) Credit: 1; Marks:25; Hours: 50;	
1. Computation of arithmetic mean, median, mode, standard deviation, Simple correlation and regression using MS EXCEL/IBM SPSS. 2. Preparation of chart, graphs using MS EXCEL/SPSS/R statistics. Suggested readings: ➤ Kothari, C. R. (2004). Research Methodology. Methods and Techniques. New Age International (P) Limited. ➤ Ronald, N. F., Eun, S. E. & Michael, H. (2007). Biostatistics. A guide to Design, Analysis, and Discovery. Academic Press. ➤ Rastogi, V. B. (2015). Biostatistics. Scientific International Pvt. Ltd. ➤ WHO (2003). Laboratory Biosafety Manual ➤ DBT (1990). Recombinant DNA safety guidelines and regulation ➤ DBT (2011). Guidelines and Handbook for Institutional Biosafety Committee (IBSC) ➤ Manual of Patent office practice and Procedure (2011). THE OFFICE OF CONTROLLER GENERAL OF PATENTS, DESIGNS & TRADEMARKS. ➤ Tenenbaum, A. S & Wetherhall, D. J. (2013). Computer Networks. Pearson Zar, J. H. (1999). Biostatistical analysis. Pearson Education Inc., New Delhi, India	

PART-IV: SEMESTER- VII

Core course

DSCC 16 RESEARCH METHODOLOGY 2	
Credit: 3; Marks: 75; Hours: 45	Hours
Unit 1: Writing of a scientific paper: Concept and importance of scientific research and review paper; shape and organization of scientific paper, ethics in scientific publishing, concept of types of plagiarisms and data piracy , organization of a paper, selection of title, authorship criteria, abstract, material and methods, results and its interpretation, discussion. Acknowledgement, Citation and its style. Writing a dissertation report.	8
Unit 2: Literature review: Definition, Purpose, types (narrating, systemic, scoping, meta-analyses, annotated bibliography), steps of literature review, criteria of good literature review, common pit-fall to avoid, Web resources for literature review : attribute and use of Google scholar, Semantic scholar, PubMed, ScienceDirect, Scopus, Web of Science, Sodhganga/INFLIBNET, National Digital Library of India.	8
Unit 3: Bibliography: Definition, types, purpose, branches of bibliography, components of a bibliography, Indian National bibliographies, Bibliographical controls. Online bibliographical tools: Use and key features of Zotero, JabRef, CiteFast, Mendeley, EndNote. UGC-care list.	4
Unit4: Presentation of research: Definition, criteria of a good presentation, Basic structure of scientific power-point presentation, slide designing principle, presenting scientific data, scientific writing style on slide, strategy for verbal presentation, Common mistake to avoid, evaluation of good scientific presentation.	10
Unit 5: Writing a research proposal for grant and preparing its report: Component of grant proposal: Abstract/Summary, Introduction and Background, Aims & objective, Hypothesis, Methodology, Work-plan and Timeline (Gantt Chart), Budget estimate and justification, Expected outcome and deliverables, Grant report format and importance of grant report. Indian Grant agencies and their project format : DST-SERB, DBT, ICMR.	7
Unit 6: Intellectual property right (IPR): Definition of IP and IPR, Categories of IP, Scope of IP, Types of IP, Importance of IPR, Evolution of IP acts and treaties, Agencies	4

responsible for IP registration, Issues affecting IP internationally.

Unit 7: Copyright and Patent: Copyright definition, importance, originality of material, Indian copyright act, copyright registration and its application. Patent definition, types of patent, Foundation of patent law, patent search in India, patent status, Basic criteria for patentability,

4

DSCC 16-P: RESEARCH METHODOLOGY 2 LAB (Practical)

Credit: 1; Marks:25; Hours: 50;

Literature survey: A review of literature to be conducted by the candidate based on research area of his/her interest followed by a seminar and viva voce in presence of one external expert and faculty members of the Department. The review of literature to be submitted after duly signed by the supervisor faculty member.

Suggested readings:

- Kothari, C. R. (2004). Research Methodology. Methods and Techniques. New Age International (P) Limited.
- Ronald, N. F., Eun, S. E. & Michael, H. (2007). Biostatistics. A guide to Design, Analysis, and Discovery. Academic Press.
- Rastogi, V. B. (2015). Biostatistics. Scientific International Pvt. Ltd.
- WHO (2003). Laboratory Biosafety Manual
- DBT (1990). Recombinant DNA safety guidelines and regulation
- DBT (2011). Guidelines and Handbook for Institutional Biosafety Committee (IBSC)
- Manual of Patent office practice and Procedure (2011). THE OFFICE OF CONTROLLER GENERAL OF PATENTS, DESIGNS & TRADEMARKS.
- Tenenbaum, A. S & Wetherhall, D. J. (2013). Computer Networks. Pearson
- Zar, J. H. (1999). Biostatistical analysis. Pearson Education Inc., New Delhi, India

INTERNSHIP

Credit: 16; Marks: 400

Every student should pursue an internship of 12 weeks in any fisheries institute of national importance/fish farm/fish processing industries/fish feed manufacturing industries or similar organization as decided by the Department of Industrial Fish and Fisheries.

Marks Distribution:

1. Submission report: 300
2. Viva: 100

EXAMINATION:

- On completion of the internship, the students will submit a report with relevant photographs and inclusive of an Attendance Document and an Authenticated Certificate from the training institute/fish farm etc.
- The report is to be signed by the Supervisor with official seal.
- A viva will be conducted by the Department with 2 Faculty acting as Internal Examiner and 1 External Examiner Appointed by University of Calcutta.
- The following Marks distribution is to be followed for evaluation 1. Submission of report: 300 marks 2. Viva Voce: 100 marks.

PART-IV: SEMESTER- VIII

Core course- Project Work

PROJECT WORK

Credit: 20; Marks: 500

The objectives of this paper are to develop a preliminary idea in pursuing research in future and learning of scientific writing. Every student should pursue a project work/research work in a potential topic under the supervision of a teacher in the Department of Industrial Fish and Fisheries. After the end of the project work, a project report having word count not less than 10,000 words excluding references to be submitted after duly signed by the respective supervisor teacher.

Marks Distribution:

1. Submission project report: 400(16 credits)
2. Grand Viva: 100 (4 credits)

EXAMINATION:

- On completion of the project work, the students will submit a report with relevant photographs as part of the report and inclusive of an Attendance Document and an Authenticated Certificate signed by the Supervisor with official seal.
- A grand viva will be conducted by the Department with 2 Faculty acting as Internal Examiner and 1 External Examiner Appointed by University of Calcutta. The student will present his/her findings using power point presentation in the presence of all the faculty members of the department.
- The following Marks distribution is to be followed for evaluation 1. Submission of report: 400 marks 2. Viva Voce: 100 marks.

MODALITIES OF SUMMER INTERNSHIP IN INDUSTRIAL FISH AND FISHERIES

Credit: 3; Marks: 75

Guidelines for the Summer Internship Programme (3 Credits) for the students of Industrial Fish and Fisheries

DURATION OF INTERNSHIP: 15 days (60 working hours) from 16th May to 30th May each year

FULL MARKS: 75 MARKS

Students may undergo internship/apprenticeship in a farm/industry/organization or training in the laboratories under the supervision of any faculty members/researchers in their OWN/other HEIs/research Institutions/ during the summer term. One/two/more of the following activities can be chosen during the training period.

ACTIVITIES

1. Biodiversity study of Crustacea/Fish in local area of the candidates.
2. Laboratory exposure [self/other HEI Institutes] inclusive of a. Laboratory reagents Preparation
b. Handling of Instruments c. Museum maintenance [preserving and cataloging specimens] d. Data analysis e. Report Preparation
3. Field based survey/minor projects to study any branch of Fisheries/ Aquaculture/Aquatic Biology in the local area of the students.

EXAMINATION:

- On completion of the Summer Internship Programme, the students will submit a report with relevant photographs as part of the report and inclusive of an Attendance Document and an Authenticated Certificate jointly signed by the Supervisor and the Head of the Institution.
- The report is to be signed by the Supervisor with official seal.
- A viva-voce will be conducted by the Department with 1 Faculty members acting as Internal Examiner and 1 External Examiner Appointed from Calcutta University
- The following Marks distribution is to be followed for evaluation 1. Submission of report: 50 marks 2. Viva Voce: 25 marks

Question pattern for Industrial Fish and Fisheries under CCF 2022

All Semesters

Discipline Specific Core Courses (DSCC)

Full marks: 75(Section A +Section B + Section C)= 20+15+40

Time: 3 hours

Examination/Paper type	Section A	Section B	Section B	Comment
Discipline Specific core Courses (DSCC) Theory	- Total 15 questions will be given by question setters - Students will attempt 10 question - Questions will be set from all the units - Each question will carry 2 marks (10X2)=20	- Total 5 short notes to be given by question setters. - Students will attempt 3 short notes - Short notes can be given from any of the units. No two short notes can be from the same unit - Each short notes will carry 5 marks(3X5)=15	- Total 7 questions to be given by question setters. - Students will attempt 4 questions. - Each carrying 10 marks. Questions can be given from any of the units. - Each question should have part questions. - Each question will carry 10 marks (10X4)=40	Total marks: 20+15+40=75 Examination would be taken at away center. Question paper will be arranged by the University. QS, MOD, HE and Examiners will be recommended by UGBOS.
Discipline Specific core Courses (DSCC) Practical	- Experiments - Identifications - Performance (17/20 Marks)	Lab Note Book: 2 Field Note Book: 3 marks	Viva 3 marks	Total Marks: 25 Examination should be taken at home centre with two internal and one external examiners recommended by UGBOS Questions will be sent by UGBOS

Industrial Fish and Fisheries Major Skill Enhancement Course (SEC) Papers:**Full marks: 75 (Section A +Section B + Section C)= 20+15+40****Time 3 hours**

	Section A	Section B	Section C	Comment
Industrial Fish and Fisheries Major SEC Theory	• Total 15 questions will be given by question setters • Students will attempt 10 question • Questions will be set from all the units • Each question will carry 2 marks (10X2)=20	• Total 5 short notes to be given by question setters. • Students will attempt 3 short notes • Short notes can be given from any of the units. No two short notes can be from the same unit • Each short notes will carry 5 marks (3X5)=15	• Total 7 questions to be given by question setters. • Students will attempt 4 questions. • Each carrying 10 marks. Questions can be given from any of the units. • Each question should have part questions. • Each question will carry 10 marks (10X4)=40	Total marks 20+15+40=75 Examination would be taken at away center. Question paper will be arranged by the University. QS, MOD, HE and Examiners will be recommended by UGBOS.
Industrial Fish and Fisheries Major SEC Practical	• Experiments • Identifications • Performance (17/20 Marks)	Lab Note Book: 2 marks Field Note Book: 3 marks	Viva: 3 marks	Total Marks: 25 Examination should be taken At home center with two internal and one external examiners recommended by UGBOS. Questions will be set by UGBOS

Amendments in Course Structure
as mentioned in Admission Regulations (Clause no. 11 of CSR/12/2023, dt.10.7.2023)
for 4-Year B.A./ B.Sc./ B.Com.--Honours with a Core Vocational subject

COURSE STRUCTURE

Semester	Core Vocational 64+36= 100		Minor (m1 & m2)	IDC	AEC	SEC	CVAC	Summer Internship	Total Credit
	Core Paper	Internship/ Project work							
	16x4= 64	2x16= 32 + Project Viva (4)= 36	8x4= 32	3x3= 9	4x2= 8	3x4=12	4x2= 8	1x3=3	172
1	1x4= 4 3TH+1P/TU		1x4= 4 (m1) 3TH+1P/TU	1x3= 3 2TH +1P/TU	1x2= 2 2TH +0P/TU	1x4= 4	2x2= 4		21
2	1x4= 4 3TH+1P/TU		1x4= 4 (m1) 3TH+1P/TU	1x3= 3 2TH +1P/TU	1x2= 2 2TH +0P/TU	1x4= 4	2x2= 4		21
3	2x4= 8 2x(3TH+1P/TU)		1x4= 4 (m2) 3TH+1P/TU	1x3= 3 2TH +1P/TU	1x2= 2 2TH +0P/TU	1x4= 4			21
4	4x4= 16 4x(3TH+1P/TU)		1x4= 4 (m2) 3TH+1P/TU		1x2= 2 2TH +0P/TU				22
5	4x4= 16 4x(3TH+1P/TU)		m1 or m2 2x4= 8 2x(3TH+1P/TU)						24
6	3x4= 12 3x(3TH+1P/TU)		m1 or m2 2x4= 8 2x(3TH+1P/TU)						20
7	1x4= 4 (3TH+ 1P/TU)	Internship 1x16= 16 (12 weeks)							20
8		Project 1x16= 16 + Project Viva (4)= 20							20
Credits	16x4= 64 + (2x16= 32+ 100	Project Viva (4)= 36)=	8x4= 32	3x3=9	4x2=8	3x4= 12	4x2=8	1x3= 3	169+3=172
Marks	16x100= 1600+	2500	8x100= 800	3x75= 225	4x50= 200	3x100 =300	4x50 = 200	1x75= 75	Total Marks =4300

Marks= 25 marks per credit.