VIDYASAGAR UNIVERSITY

Midnapore, West Bengal

PROPOSED CURRICULUM&SYLLABUS (DRAFT) OF

BACHELOR OF SCIENCE (HONOURS)

MAJOR IN AQUACULTURE MANAGEMENT

4-YEAR UNDERGRADUATE PROGRAMME

(w.e.f. Academic Year 2023-2024)

Based on

Curriculum & Credit Framework for Undergraduate Programmes

(CCFUP), 2023& NEP, 2020

VIDYASAGAR UNIVERSITY
BACHELOR OF SCIENCE (HONOURS) MAJOR IN AQUACULTURE MANAGEMENT
(under CCFUP, 2023)

Level	YR.	SEM	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
								CA	ESE	TOTAL
B.Sc. (Hons.)	3rd	V	SEMESTER-V							
			Major-8	ACMHMJ08	T: Freshwater Aquaculture; P: Practical	4	3-0-1	15	60	75
			Major-9	ACMHMJ09	T: Biology of Finfish and Shellfish; P: Practical	4	3-0-1	15	60	75
			Major-10	ACMHMJ10	P: Aquatic Ecology and Biodiversity; P: Practical	4	3-1-0	15	60	75
			Major Elective-01	ACMHDSE1	T: Coastal Aquaculture and Mariculture; P: Practical	4	3-1-0/ 3-0-1	15	60	75
			Minor-5 (Disc.-I)	ACMMIN05	T: Fish Nutrition and feeding strategies; *(To be taken from other Discipline)*	4	3-1-0	15	60	75
					Semester-V Total	20				375
		VI	SEMESTER-VI							
			Major-11	ACMHMJ11	T: Aquatic Pollution and mitigation; P: Practical	4	3-0-1	15	60	75
			Major-12	ACMHMJ12	T: Fishing craft and gear Technology; P: Practical	4	3-0-1	15	60	75
			Major-13	ACMHMJ13	T: Fisheries Co-operative and Marketing; P: Practical	4	3-0-1	15	60	75
			Major Elective-02	ACMHDSE2	T: Fishery Oceanography	4	3-1-0/ 3-0-1	15	60	75
			Minor-6 (Disc.-II)	ACMMIN06	T: Advanced Aquaculture systems *(To be taken from other Discipline)*	4	3-1-0	15	60	75
					Semester-VI Total	20				375
					YEAR-3	40				750
			Eligible to be awarded Bachelor of Science in Aquaculture Management *on Exit*			126	Marks (Year: I+II+III)			2325

MJ = Major, MI = Minor Course, DSE = Discipline Specific Elective Course, CA= Continuous Assessment, ESE= End Semester Examination, T = Theory, P= Practical, L-T-P = Lecture-Tutorial-Practical

SEMESTER-V

MAJOR (MJ)

MJ-8: Freshwater Aquaculture **Credits 04 (Full Marks: 75)**

Course Objectives:

1. To develop an understanding of contemporary practices and innovations in freshwater aquaculture across diverse culture systems.

2. To familiarize students with various aquaculture techniques and key freshwater fish and shellfish species of commercial significance.

MJ-8T: Freshwater Aquaculture (Theory) **Credits 03**

Course contents:

Study of major cultured species, global production trends, and future prospects of aquaculture. Exploration of freshwater resources such as ponds, tanks, lakes, and reservoirs. Preparation and management of nursery, rearing, and grow-out ponds including control of weeds, predatory fishes, liming, manuring, biofertilizer use, and supplementary feeding. Principles of water quality management, seed selection, transportation, and acclimatization. Traits and culture methods of important fishes and shellfishes - Indian and exotic carps, air-breathing and cold-water fishes, freshwater prawns and mussels. Wintering ponds, quarantine ponds and isolation ponds. Concepts of sewage-fed fish culture, organic cycling, and detritus food chains. Concept of monoculture, polyculture and composite fish farming. Integration of aquaculture with agriculture, horticulture, livestock, and aquatic macrophytes like makhana, including paddy-cum-fish/shrimp culture systems.

MJ-8P: Freshwater Aquaculture (Practical) **Credits 01**

Course Outline:

Preparation and management of nursery, rearing, and grow-out ponds; evaluation of the effects of liming, manuring, and fertilization on pond hydrobiology and the growth of fish and shellfish. Collection, identification, and control of aquatic weeds, insects, predatory and weed fishes, and fish eggs or larvae. Study of algal blooms and their management. Estimation of plankton and benthic biomass, and assessment of natural and supplementary feed contributions to fish growth. Economic analysis of various culture practices, estimation of livestock requirements in integrated aquaculture, and design of paddy plots, fish/shrimp culture systems, and livestock sheds on pond embankments for integrated farming efficiency.

Suggested readings

1. Agarwal SC. 2008. A Handbook of Fish Farming. 2nd edn. Narendra Publ. House.
2. FAO. 2007. Manual on Freshwater Prawn Farming.
3. ICAR. 2017. Handbook of Fisheries and Aquaculture.
4. Jhingran V.G. 1991. Fish and Fisheries of India, 3rd edn, Hindustan Publ.
5. Pillay TVR and Kutty MN. 2005. Aquaculture- Principles and Practices. Blackwell.
6. Rath R. K. 2000. Freshwater Aquaculture. Scientific Publ.

MJ-9: Biology of Finfish and Shellfish **Credits 04(Full Marks: 75)**

Course Objectives

1. To understand key morphological features, growth patterns, adaptations, and developmental stages of major finfish and shellfish important to aquaculture.

2. To develop practical skills in species identification, growth assessment, anatomical study, and life-cycle observation of finfish and shellfish.

MJ-9T: Biology of Finfish and Shellfish (Theory) **Credits 03**

Course contents:

Study of the morphology of fish, body shape, skin, colouration, scales, mouth, jaws, teeth, fin and fin rays; lateral line system. Outlines of skeletal system. Isometric and allometric growth; cube law. Analysis of growth check on hard parts (Scale, otolith, vertebrae). Marking and tagging for growth studies; length–weight relationship, ponderal index and relative condition factor; bioluminescence; electric organs and their physiology. Adaptation to different habitats. Population studies. Parental care strategies; Food and feeding habits of common cultivable fishes and shellfishes. Embryonic development, larval stages, and metamorphosis in finfish and shellfish. General life cycles of major finfish (carps, catfishes, murrels etc.) and shellfish (prawns, crab, lobsters, bivalves, gastropods, cephalopods, echinoderms etc.) groups from different habitats relevant to aquaculture and fisheries.

MJ-9P: Biology of Finfish and Shellfish (Practical) **Credits 01**

Course Outline:

Identification mouth types, jaws, teeth, fins and fin rays of finfish and shellfish. Study of the different types of scales of fishes. Weberian ossicles of Indian Major carp. Preparation of finfish skeletons. Mounting of appendages of Prawn/Shrimp. Determination of isometric/allometric growth and cube law. Study of growth rings on scales, otoliths, and vertebrae. Study of bioluminescent and electric organs. Gill rakers of fishes of different feeding habit. Observation of larval and juvenile stages of finfish and shellfish. Preparation of life-cycle charts of selected species.

Suggested Reading:

1. **Lagler, K. F., Bardach, J. E., Miller, R. R., & Passino, D. R. M.** (1977). *Ichthyology* (2nd ed.). New York: John Wiley & Sons. **552 pp.**
2. **Nikolsky, G. V.** (1963). *The Ecology of Fishes.* London: Academic Press. **352 pp.**

3. **Jhingran, V. G.** (1991). *Fish and Fisheries of India* (3rd ed.). New Delhi: Hindustan Publishing Corporation. **954 pp.**
4. **Srivastava, C. B. L.** (1985). *Fishery Biology.* Allahabad: Kitab Mahal. **223 pp.**
5. **Biswas, S. P.** (1993). *Manual of Methods in Fish Biology.* New Delhi: American Press. **188 pp.**
6. Derek Burton, D. and Burton, M. 2017. Essential Fish Biology: Diversity, structure, and function, Oxford University Press.
7. Paul, J., Hart, B. and Reynolds, J. D. (Editors), 2002. Handbook of Fish Biology and Fisheries: Fisheries, Volume 2, Blackwell Science Ltd.
8. Venkataramanujam, K. and Ramanathan, N. 1994. Manual of Finfish Biology. Oxford and IBH publishing Co. Pvt. Ltd 1108.
9. **Prasad, R. R., & Raghavan, R.** (2005). *Fish Biology and Ecology.* New Delhi: Discovery Publishing House. **280 pp.**
10. **Sharma, O. P.** (2010). *Ichthyology* (2nd ed.). Meerut: Rastogi Publications. **Approx. 300 pp.**

MJ-10: Aquatic Ecology and Biodiversity **Credits 04 (Full Marks: 75)**

Course Objectives

1. To develop a deeper understanding of aquatic ecological processes and biodiversity.
2. To evaluate the major threats impacting aquatic ecosystems and their biological diversity.

MJ-10T: Aquatic Ecology and Biodiversity (Theory) **Credits 03**

Course contents:

Major components of aquatic ecosystems: physical, chemical, and biological elements. Discussion on aquatic productivity, nutrient cycling, energy transfer, and the structure of food chains. Animal interactions: symbiosis, commensalism, parasitism, predator–prey relationship, and host–parasite relationships. Aquatic biodiversity-its importance, species diversity, genetic diversity, habitat diversity, diversity indices. Ecological and evolutionary processes. Ecological niches – lagoons, estuaries, mangroves, coral reefs, flood plains, coastal wet lands, bheels, oxbow lakes. Threats to biodiversity- habitat destruction, introduction of exotic species. Conservation of habitats: marine parks and sanctuaries. Conservation programs for endangered species, ex situ and in situ conservation, captive breeding and management of endangered species. Various national and international conventions and regulations concerning biodiversity, including use of selective gears and exclusion devices.

MJ-10T: Aquatic Ecology and Biodiversity (Practical) **Credits 01**

Collection of species of fishes and other organisms and studying the assemblages of organisms of rocky, sandy and muddy shores, lentic and lotic habitats. Observation of adaptive characters and interrelationships like commensalisms, symbiosis, parasitism and predation. Field visits to mangroves, marine parks, sanctuaries, coral reefs, rivers, hills, streams, lakes and reservoirs. Collection, identification, and preservation of mangrove plants. Working out biodiversity indices.

Suggested readings:

1. Andy D Ward, Stanley W Trimble, Suzette R Burckhard and John G Lyon. 2015. Environmental Hydrology, CRC press.
2. Barnes RSK and Mann KH. eds. 2009. Fundamentals of aquatic ecology. John Wiley and Sons.
3. Carter RWG. 1998. Coastal Environments: An Introduction to the Physical, Ecological and Cultural Systems of Coastlines. Academic Press, London.
4. Dodds W and Whiles M. 2010. Freshwater Ecology, 2nd edn, Concepts and Environmental Application of Limnology. Academic Press, London.

5. Khanna DR, Chopra AK and Prasad G. 2005. Aquatic Biodiversity in India. Daya Publ. House.
6. Kormondy EJ. 1986. Concepts of Ecology, Prentice-Hall, New Delhi.
7. Menon AGK. 2004. Threatened Fishes of India and their Conservation. Fisheries Survey of India.
8. Nath S. (Ed). 2008. Recent Advances in Fish Ecology Limnology and Eco Conservation Vol 7. Narendra Publishing House, New Delhi

MAJOR ELECTIVE (DSE)

Major Elective -1: Coastal Aquaculture and Mariculture **Credits 04 (Full Marks: 75)**

Course Objectives

1. To gain knowledge on the culture of coastal and marine fish and shell-fish species
2. To acquire knowledge of coastal marine farming of fish and shell-fish

MJ DSE-1T: Coastal Aquaculture and Mariculture (Theory) **Credits 03**

Course contents:

Overview of sea farming and shore-based aquaculture across different regions of the world. Study of India's coastal and marine resources suitable for shore-based aquaculture and mariculture. Characteristics and culture techniques of key cultivable fishes and shellfishes such as seabass, mullet, milkfish, grouper, cobia, snappers, ayu, pearl spot, tiger and white shrimp, mud crab, mussel, clam, oysters (edible and pearl), and lobster. Seaweed and pearl culture practices. Seed resources and culture systems - traditional (pokkali, bheries, gazanis, khazans), semi-intensive, and intensive methods. Techniques of shellfish culture using rafts, racks, cages, poles, and ropes. Water and soil quality management, estimation of growth, survival, and productivity, and practices of sea ranching.

MJ DSE-1P: Coastal Aquaculture and Mariculture (Practical) **Credits 01**

Identification of important cultivable species. Collection and identification of commercially important seeds of fish and shellfish. Types of fertilizers - Pond preparation. Seed selection, quality, and acclimatization. Water quality parameters. Estimation of seed survival. Pond biomass estimation. Material, apparatus and machinery for shore-based aquaculture and sea farming. Estimation of feed intake. Growth and health monitoring. Fouling organisms in cages and pens.

Suggested Readings:

1. Gunn A. (2009) *Essential Forensic Biology* (2nd ed). Chichester: Wiley-Blackwell.
2. Byers, S. N. (2008). Forensic Anthropology. Boston: Pearson Education LTD.
3. Reddy V. R. (1985). Dental Anthropology, Inter-India Publication, New Delhi.
4. Spencer, C. (2004). Genetic Testimony: A Guide to Forensic DNA Profiling, Pearson, New Delhi.
5. Vats Y., Dhall J.K. and Kapoor A.K. (2011). Gender Variation in Morphological Patterns of Lip Prints among some North Indian Population. J. Forensic Odontology, 4: 11-15.
6. Wilkinson, C. (2004). Forensic facial reconstruction. Cambridge University Press.

MINOR (MI)

Minor (MI)-5: Fish Nutrition and feeding strategies **Credits 04(Full Marks: 75)**

Course Objectives

1. To understand the principles of fish and shellfish nutrition to formulate quality feeds, adopt efficient feeding strategies, and evaluate feed performance.

2. To identify nutrient deficiencies, assess feed quality, and implement suitable measures to enhance growth, health, and productivity in aquaculture systems.

Minor (MI)-5T: Fish Nutrition and feeding strategies **Credits 03**

Course contents:

Fundamentals of Fish Nutrition and Growth. Nutrients and Nutritional Requirements for cultivable fish and shellfish species. Methods of Feed Formulation and Preparation**.** Types of Feeds**:** Wet, moist, and dry feeds; mashes; pelleted feeds; floating and sinking pellets. Use of preservatives, antioxidants, and appropriate storage methods to maintain feed quality. Techniques for efficient feed delivery, optimal feeding schedules, rationing, and feeding frequency to enhance growth and minimize wastage. Feed conversion ratio (FCR), feed efficiency ratio (FER), protein efficiency ratio (PER), net protein utilization (NPU) and biological value. Identification, causes, and preventive measures for deficiency-related diseases.

Suggested Readings:

1. Halver, J.E. & Hardy, R.W. (Eds.) (2002). Fish Nutrition (3rd ed.). Academic Press.
2. Lovell, R.T. (1998). Nutrition and Feeding of Fish. Kluwer Academic Publishers.
3. Tacon, A.G.J. (1987). The Nutrition and Feeding of Farmed Fish and Shrimp. FAO Field Document, FAO, Rome.
4. De Silva, S.S. & Anderson, T.A. (1995). Fish Nutrition in Aquaculture. Chapman & Hall.
5. Wilson, R.P. (1991). Handbook of Nutrient Requirements of Finfish. CRC Press.
6. Jobling, M. (2016). Fish Nutrition Research Advances. Cambridge Scholars Publishing.
7. Hardy, R.W.& Kaushik, S.J. (Eds.) (2021). Aquafeed Formulation: Beyond Fishmeal. Academic Press.
8. FAO Aquaculture Technical Papers (Various years). *Fish Feed Technology, Feed Formulation, Quality Evaluation*, FAO, Rome.

SEMESTER-VI

MAJOR (MJ)

MJ-11: Aquatic Pollution and mitigation **Credits 04 (Full Marks: 75)**

Course Objectives

1. To understand key aspects, types, and impacts of aquatic pollution on freshwater and marine environments.
2. To identify major pollution sources and apply appropriate control and mitigation measures for ecosystem protection.

MJ-11T: Aquatic Pollution and mitigation (Theory) **Credits 03**

Course contents:

Introduction to aquatic pollution; sources of pollutants, toxic organic compounds, and their effects on aquatic organisms and the abiotic environment. Classification of pollution into physical, chemical, and biological types. Sewage and domestic wastes; composition, pollution effects, treatment, reuse, and mitigation through advanced wastewater treatment and recycling. Agricultural wastes, organic detritus, nutrients, and their influence on dissolved oxygen, oxygen demand (BOD, COD), and oxygen budget; Biological impacts of organic matter, eutrophication, red tides, and fish kills; mitigation through aeration, nutrient load reduction, and phytoremediation. Pesticide types and categories; inorganic pesticides, organochlorines, organophosphates, PCBs; bioaccumulation and effects on aquatic fauna and human health.

Definitions and branches of toxicology; historical developments; classification of poisons. Types of poisoning, toxicity testing, diagnosis, and factors modifying toxicity. Toxicokinetics and toxicodynamics. Heavy metals, oil pollution, microbial contamination, radioactive and thermal pollution, and industrial effluents. Mitigation through effluent treatment, bioremediation, phytoremediation, and regulatory compliance. Monitoring and control of pollution; use of biological indicators, solid waste management, and environmental regulations to reduce pollutant loads.

MJ-11P: Aquatic Pollution and mitigation (Practical) **Credits 01**

Course Outline:

Estimation of physio-chemical characteristics of polluted waters: Colour, Odour, Turbidity, pH, salinity, total alkalinity, total hardness, BOD, COD, Hydrogen sulphide, phosphates, ammonia, nitrates, nitrites, heavy metals in water. Determination of pH, conductivity, organic carbon,

nitrogen, phosphorus, heavy metals in sediments. Bacteriological tests of waste water. Study of flora and fauna of polluted water, pollution indicator species (algae, protozoa and insect larva), bioassay and methods of toxicity study.

Suggested Readings

1. APHA (American Public Health Association). 2017. Standard Methods for the Examination of Water and Wastewater. 23rd edn. American Public Health Association, Washington, D.C.
2. Qayoom, I., Abubakr, A., Gopinath, A., Dar, S.A., & Khurshid, K. (Eds.) (2025). Aquatic Pollution: Concerns and Abatement. CRC Press. (314 pp.).
3. Reichelt-Brushett, A. (Ed.) (2023). Marine Pollution – Monitoring, Management and Mitigation. Springer. (369 pp.).
4. Mukherjee, S., Joshi, S.J., Paul, S., & Kundu, R. (Eds.) (2024). Toxicity of Aquatic System and Remediation: The Contemporary Issues. CRC Press. (302 pp.)
5. Baird DJ, Beveridge MCM, Kelly LA and Muir JF. 1996. Aquaculture and Water Resources Management. Blackwell Science Ltd., Oxford.
6. Clark RB. 2001. Marine Pollution. Oxford University Press.
7. Boudou, A. (1989). Aquatic Ecotoxicology, Volume 2: Fundamental Concepts and Methodologies. CRC Press. (350 pp.).
8. Czernuszenko W and Rowinski P. 2005. Water Quality Hazards and Dispersion of Pollutants. Springer Science and Business Media.
9. Gray NF. 2004. Biology of Wastewater Treatment. Oxford University Press, London.
10. Mason C. 2002. Biology of Freshwater Pollution. 4th edn, Benjamin Cummings, 400 pp.

MJ-12: Fishing craft and gear Technology **Credits 04 (Full Marks: 75)**

Course Objectives

1. To learn design and modification of fishing crafts design.
2. To learn design modification and gear selectivity of fishing.

MJ-12T: Fishing craft and gear Technology (Theory) **Credits 03**

Course contents:

Introduction to the history and development of fishing crafts, including traditional Indian boats and mechanization. Classification based on fabrication, fishing type, and operational depth. Basic geometry, vessel terminology, form coefficients, and area calculations using Trapezoidal and Simpson's rules. Principles of equilibrium, displacement, centers of gravity and buoyancy, and vessel stability. Overview of tonnage systems. Boat-building materials and their properties, deck fittings, maintenance, preservation, and construction details for wooden, steel, FRP, ferro-cement, and aluminum boats. Introduction to outboard and inboard engines.

Evolution of fishing gears. Basic classification of gears: principle, subsidiary, auxiliary; FAO & International Standard Statistical Classification of Fishing (ISSCFG) standards. Fishing gear materials: natural and synthetic, preparation, identification, yarn/fibre types. Construction of netting, ropes, knotted/knotless webbing, mesh shapes. Properties of netting: physical, chemical, biological; floats, buoys, sinkers, buoyancy calculations. Design considerations: biological, environmental, vessel, mesh size. Types of gears: trawl, gillnet, purse seine, line, traps, beach/boat seine. Gear rigging, accessories, otter doors, deck layout. Fishing operations, selectivity, by-catch reduction. Fishing equipment: winches, haulers, GPS, sonar, fish finders.

MJ-12P: Fishing craft and gear Technology (Practical) **Credits 01**

Course Outline:

Studies on traditional fishing crafts; Identification of traditional and modern fishing crafts and gears used in different aquatic system of India. Identification of fishing accessories (Floats/sinkers/synthetic & natural fibres/hooks/baits etc.). Craft building material. Study of the different fish finding devices. Introduction to drawing and drawing instruments; Lettering, Geometrical construction, Curves. Projections; Projection of points, planes and Projection of solids; lines plan drawing. Drawing of sheer plan, body plan and half breadth plan. Types of marine engines and their installation of engines. Visit to boat building yard and dry dock.

Study of net making tools; gear preparing materials. Methods of net making: Hand braiding- Chain mesh method and loop methods of net making. Shaping of webbing. Tailoring method. Joining of

net pieces. Mending and net shooter techniques. Survey of fishing gears; Trawl; gillnet; long line and purse seine fishing gears. Rigging of trawl, purse seine, gillnet and hook and line. Commercial fishing techniques: Bottom trawling; purse seining; gillnetting and line fishing. Cast net fishing and trap fishing.

Suggested Reading:

1. Fyson JF. (ed). 1985. Design of Small Fishing Vessels, Fishing News Books, Oxford.
2. Ponnambalam A. 2003. Fishing Craft Technology. CIFNET. Cochin: 158p.
3. Sanisbury JC. 1996. Commercial Fishing Methods-an Introduction to Vessels and Gear, Fishing News Books Ltd., Farnham, 352p.
4. Yadav YS. 2002. Traditional Fishing Craft of the Bay of Bengal. BOBP. Chennai: 55p
5. Biswas KP. 1996. Harvesting Aquatic Resources. Daya Publishing House, Delhi: 207 p.
6. Bjordal and Lokkeborg S. 1998. Long Lining, Fishing News Books Ltd. Farnham, 208p.
7. FAO. 1996. Fishing Operations, FAO Training Guidelines for responsible fisheries No.1, FAO, Rome 26p
8. Fridman AL. 1986. Calculations for Fishing Gear Designs, FAO Fishing manual, Fishing News Books, Ltd., Farnham, 264p.
9. Kristionsson H. 1975. Modern Fishing Gear of the World. The White Friars Press Limited. London: 594 p.
10. Sreekrishna Y and Shenoy Latha. 2001. Fishing Gear and Craft Technology. Indian Council of Agricultural Research. New Delhi, 342

MJ-13: Fisheries Co-operative and Marketing **Credits 04 (Full Marks: 75)**

Course Objectives

1. To understand fisheries co-operatives, their management, legal framework, and role in supporting fishers and production.
2. To learn fish marketing, value addition, cold-chain management, and cooperative-led initiatives for community development.

MJ-13T: Fisheries Co-operative and Marketing (Theory) **Credits 03**

Course contents:

Introduction to fisheries co-operatives: history, objectives, and significance in India and West Bengal. Structure, types, and legal framework of co-operatives; Roles of central, state, and apex fisheries co-operatives in credit, input supply, and marketing. Principles of co-operative management, leadership, and decision-making. Marketing of fish and fishery products: channels, pricing, demand-supply analysis, and seasonal fluctuations. Government policies, subsidies, and support programs (NFDB, MPEDA, State Fisheries Department schemes). Case studies of successful West Bengal fishery co-operatives. Storage, handling, and cold chain management. Role of co-operatives in improving fish quality, reducing post-harvest losses, and enhancing fisher income. Market intelligence, branding, and value addition. Fish auctions, e-marketing, and cooperative-led retail initiatives. Socio-economic impact on small-scale fishers and community development.

MJ-13P: Fisheries Co-operative and Marketing (Practical) **Credits 01**

Course Outline:

Field visits to local fishery co-operatives and markets. To gain knowledge on cooperative registration, record-keeping, and governance. Market surveys and price analysis. Exposure to e-marketing platforms, fish auctions, and cooperative-led supply chain management.

Suggested Reading:

1. **FAO Fisheries Circular**. (2020). *Post-Harvest Practices and Marketing of Fish*. Rome: FAO.
2. **MPEDA Bulletin**. (2022). *Fish Marketing and Export*. Cochin: MPEDA Publications.
3. **NFDB Manuals**. (2021). *Fisheries Co-operative Management and Development*. Hyderabad: NFDB.
4. **Rao, K.V.** (2015). *Fisheries Co-operatives in India*. New Delhi: ICAR.
5. **Sarkar, S. & Ghosh, A.** (2018). *Fish Marketing and Management in West Bengal*. Kolkata: Kalyani Publishers.

MAJOR ELECTIVE (DSE)

Major Elective -2: Fishery Oceanography **Credits 04 (Full Marks: 75)**

Course Objectives

1. To provide students with knowledge of fisheries-related oceanographic principles and train them in the use of oceanographic instruments.

2. To understand the role of various oceanographic factors influence fisheries productivity.

MJ DSE-2T: Fishery Oceanography (Theory) **Credits 04**

Course contents:

Introduction to Oceanography: classification; Earth and the ocean basin, distribution of water and land; relief of sea floor; Major feature of topography and terminology; major divisions. Ocean Waves: definition and terms; classification. Difference between surface and long waves; wave theories; surface wave generation; spreading growth; Beaufort scale. Ocean Tides: Definition; Tidal phenomenon, elementary tidal definition; tidal inequalities; tide producing forces types of tides tidal bores, tide prediction. Ocean Currents: Definitions and features; drift currents, Ekman spirals, upwelling, sinking, gradient currents; thermohaline circulation; characteristics; course; and significance of some major ocean currents of the world. El Nino and Southern Oscillation. Physical properties of sea water: Salinity and chlorinity; temperature; thermal properties of sea water; colligative and other properties of sea water. Properties of sea ice; transmission of sound; absorption of radiation; eddy conductivity; diffusivity and viscosity. General distribution of temperature, salinity and density: Salinity and temperature of surface layer (SST), subsurface; distribution of temperature and salinity; The T-S diagram. Chemistry of sea water: Constancy of composition; elements present in sea water; artificial sea water; dissolves gases in sea water; CO2 system and alkalinity; inorganic agencies affecting composition of sea water distribution of phosphorus, nitrogen compounds, silicates and manganese in the oceans, factor influencing their distribution. Environmental factors influencing the seasonal variations in fish catch in the Arabian Sea and the Bay of Bengal.

Suggested readings

1. Grasshoff K, Ehrhardt M and Kremling V. 1983. Methods of Seawater Analysis. Verlag Chemie, Weinheim.
2. Kennish MJ. 1989. Practical Handbook of Marine Science. CRC Press, New York.
3. Laevastu T and Hayes ML. 1981. Fisheries Oceanography and Ecology. Fishing News Books, Farnham, U.K.

4. Lalli CM and Parsons TR. 1993. Biological Oceanography: An Introduction. Elsevier Science Ltd., Oxford.
5. Miller CB. 2004. Biological Oceanography. Blackwell Publications, Oxford.
6. Pond S and Pickard GL. 2013. Introductory Dynamical Oceanography. Elsevier.
7. Reddy MPM. 2007. Ocean Environment and Fisheries, Science Publishers, USA.
8. Tomczak M and Godfrey JS. 2013. Regional Oceanography: An Introduction. Elsevier.

MINOR (MI)

Minor (MI)-6: Advanced Aquaculture systems **Credits 04(Full Marks: 75)**

Course Objectives

1. To learn advanced aquaculture techniques, including RAS, integrated systems, and sustainable practices, for efficient fish and shellfish production.

2. To gain knowledge on water quality, feeding, health, and environmental impacts using modern technologies and biosecurity measures in aquaculture.

Minor (MI)-6T: Advanced Aquaculture systems (Theory) **Credits 04**

Course contents:

Overview of advanced aquaculture systems. Intensive, semi-intensive, and recirculating aquaculture systems (RAS). Water quality management: monitoring, aeration, filtration, and biosecurity measures. Aquaculture engineering: pond, tank, cage, and raceway systems. Integrated and sustainable practices: aquaponics, polyculture, rice–fish farming, and system optimization. Feeding strategies, growth monitoring, and health management for local aquaculture species. Environmental impact assessment, waste management, and disease prevention strategies. Use of modern technologies: automated feeders, IoT-based monitoring, smart aquaculture tools.

Suggested readings

1. FAO. (2019). *Aquaculture production systems and practices*. Rome, Italy: Food and Agriculture Organization.
2. Khune, C. J., Tijare, R. V., Sitre, S. R., & Zade, S. B. (2015). *Principles of aquaculture.* Hyderabad, India: Himachal Publishing.
3. Singh, N. P., & Santhosh, B. (2018). *Handbook on freshwater aquaculture*. New Delhi, India: Vedams Books.
4. Tanveer, M., Pradeep, R., & Jasmin, S. A. (2020). *Aquaculture machineries and equipment.* New Delhi, India: NIPA Publications.
5. Timmons, M. B., Guerdat, T., & Vinci, B. J. (2018). *Recirculating aquaculture systems: Principles, design, and operations* (5th ed.). Ithaca, NY: Cayuga Aqua Ventures.
6. Yadav, N. K., et al. (2021). *Advances in freshwater aquaculture: Technology for sustainable development.* Apple Academic Press.