

OUTCOME BASED EDUCATION (OBE)

CURRICULUM BASED SYLLABUS

2024



M. Sc. INDUSTRIAL FISHERIES

SCHOOL OF INDUSTRIAL FISHERIES

COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

OUTCOME BASED EDUCATION (OBE), CURRICULUM BASED SYLLABUS FOR
M.Sc. INDUSTRIAL FISHERIES PROGRAMME

Background

UGC has made it mandatory to follow the system of Choice Based Course (CBC) and Outcome Based Education (OBE), as our PG courses with fairly well updated contents have been under choice based credit and semester system. Courses are well designed instruction packages in specific knowledge fields, with preconceived results that go into the making of the outcome of the Academic Programme. They are scientifically structured with insights of continuity, sequence, and integration, appropriate for effective learning. Workshops are organized in different universities in the state in this direction for the Board of Studies for redesigning the courses at the UG/PG level.

A high priority task in the context of future education development agenda in India is fostering quality higher education. Further improvement of quality of higher education is considered critical

for enabling effective participation of young people in knowledge production and participation in the knowledge economy, improving national competitiveness in a globalized world and for equipping young people with skills relevant for global and national standards and enhancing the opportunities or social mobility. Sustained initiatives are required for institutionalizing an outcome-oriented higher education system and enhancing employability of graduates through curriculum reform based on a learning outcomes-based curriculum framework, improving/upgrading academic resources and learning environment, raising the quality of teaching and research across all higher education institutions; technology use and integration to improve teaching-learning processes and reach a larger body of students through alternative learning modes such as open and distance learning modes and use of MOOCs. Other priority areas of action for fostering quality higher education include translation of academic research into innovations for practical use in society and economy, promoting efficient and transparent governance and management of higher education system, enhancing the capacity of the higher education system to govern itself through coordinated regulatory reform and increasing both public and private sector investment in higher education, with special emphasis on targeted and effective equity-related initiatives (<https://www.ugc.ac.in/>.) With this prelude, the curriculum based syllabus MSc Industrial Fisheries course is amended based on the Outcome Based Education.

School of Industrial Fisheries has been successfully conducting the Multi-disciplinary Masters Programme in Industrial Fisheries since 1976. Periodic revisions of the curriculum have been effected depending on the changing “Academic, Research and Industrial Requirements” both within the country and abroad. This Professional Post Graduate Degree Programme is one of the main sources of human resource for the fisheries industry, academic and research institutions in India and abroad. Several Central Government/State Government Fisheries Institutions/Departments recruit post graduates from this School. The entrepreneurial skill acquired from this programme has given confidence to the post graduates to venture into their own business in different facets of fisheries. The employability of this programme has been attracting talented students from both within the state and outside states to join this programme.

Program Outcomes (MSc Industrial Fisheries)

PO1 - Apply the knowledge of fisheries science, technology, economics and management disciplines to the solution of complex problems in the field of fisheries.

PO2 - Identify, formulate, review research literature, and analyze complex problems reaching substantiated conclusions using the principles of fisheries science, technology, economics and management

PO3 - Design solutions for complex problems in the field of fisheries and specified needs with appropriate considerations for the industrial, societal and environmental needs.

PO4 - Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 - Create, select and apply appropriate techniques, resources, and modern tools pertaining to aquaculture, fisheries resource management, seafood processing, fisheries business management with an understanding of the limitations.

PO6 - Communicate effectively on complex activities with all the stakeholders and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give/ receive clear instructions.

PO7 - Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them

PO8 - Understand the impact of challenges in fisheries in an industrial and societal context and to demonstrate knowledge for sustainable development

PO9 - Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to fisheries practice.

PO10 - Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Program Specific Outcome - MSc Industrial Fisheries

PSO1 - Ability to apply concepts, tools and techniques in capture fisheries, aquaculture, seafood processing, marketing, fisheries economics & management to identify and solve problems in the industrial fisheries setting.

PSO2 - Demonstrate knowledge on diverse aspects of industrial and entrepreneurial applications of aquaculture & fisheries, harvest and post harvest technology of fish, fisheries economics, and fisheries business management

PSO3 - Understanding the functioning of all fisheries related activities in the industrial setting including harvesting, processing, marketing and trade.

PSO 4- Demonstrate professional, managerial and entrepreneurial skills to meet the current and future challenges in corporate and public sectors

Faculty of Marine Sciences
School of Industrial Fisheries
Cochin University of Science and Technology
Scheme & Syllabus applicable from 2024 Admission

FIRST SEMESTER

Course Code	Title of the Course	Credits	Core/ Elective	Marks		
				Continuous Assessment	End Sem. Exam.	Total
24-308- 0101	Taxonomy and Systematics of Commercially Important Fin Fishes and Shell Fishes	3	C	50	50	100
24-308-0102	Fishery Biology	3	C	50	50	100
24-308-0103	Principles of Fish Harvest Technology	3	C	50	50	100
24-308-0104	Fish Biochemistry	3	C	50	50	100
24-308-0105	Managerial Economics	4	C	50	50	100
24-308-0106	Principles of Fish Business Management	4	C	50	50	100
24-308-0107	Research Methodology and Quantitative Techniques for Fisheries	4	C	50	50	100
24-308-0108	Elective 1	2	E	50	50	100
24-308-0109	Elective 2	1	E	100	-	100
24-308-0110	Elective 3	1	E	100	-	100
Maximum Total Credit Offered in 1 st Semester: 28 (24 credits for Core and 04 credits for Elective Courses)						

ELECTIVES

Sl. No.	Course	Credit	Elective
1.	Introduction to Fisheries Industry and Institutions	2	E
2.	Entrepreneurship Development in Fisheries	2	E
3.	Fish Taxonomy & Biology (Practical)	1	E
4.	Fish Biochemistry (Practical)	1	E

SECOND SEMESTER

Course Code	Title of the Course	Credit	Core/ Elective	Marks		
				Continuous assessment	End Sem. Exam.	Total
24-308-0201	Fisheries Resources Management	3	C	50	50	100
24-308-0202	Design and Construction of Fish Harvesting Systems	3	C	50	50	100
24-308-0203	Chilling and Freezing Technology	2	C	50	50	100
24-308-0204	Thermal, Non-thermal Processing and Packaging Technology	3	C	50	50	100
24-308-0205	Production and Operations Management in Fisheries Industry	4	C	50	50	100
24-308-0206	Economics of Fisheries Production & Marketing	3	C	50	50	100
24-308-0207	Elective -1	2	E	50	50	100
24-308-0208	Elective- 2	2	E	50	50	100
24-308-0209	Elective- 3	1	E	100	-	100
24-308-0210	Elective- 4	1	E	100	-	100
24-308-0211	Elective- 5	4	E	100	-	100
Maximum Total Credits offered in Second Semester: 28 Credits (18 Credits for Core and 10 Credits for Elective Courses)						

ELECTIVES

Sl. No.	Course	Credit	Elective
1.	Global Aquaculture Practices	2	E
2.	Analytical Methods for Seafood Quality Assurance	2	E
3.	Oceanic and Deep Sea Fisheries	2	E
4.	Fish Processing Technology (Practical)	1	E
5.	Fishing Gear Technology (Practical)	1	E
6.	Case Study on Economics of Fisheries Production and Marketing	1	E
7.	Internship in Seafood Industry	4	E

THIRD SEMESTER

Course Code	Title of the Course	Credit	Core/ Elective	Marks		
				Continuous Assessment	End Sem. Exam.	Total
24-308-0301	Hatchery Technology of Cultivable Finfishes and Shellfishes	3	C	50	50	100
24-308-0302	Value Added Products Technology	3	C	50	50	100
24-308-0303	Advancements in Fishing Technology and Responsible Fishing Approaches	3	C	50	50	100
24-308-0304	Sustainable Fisheries Management	3	C	50	50	100
24-308-0305	Marketing Management	3	C	50	50	100
24-308-0306	Economics of Sustainable Fisheries Development	3	C	50	50	100
24-308-0307	Elective- 1	3	E	50	50	100
24-308-0308	Elective- 2	3	E	50	50	100
24-308-0309	Elective- 3	3	E	50	50	100
24-308-0310	Elective- 4	1	E	100	-	100
24-308-0311	Elective- 5	1	E	100	-	100
Maximum Total Credits offered in Third Semester: 29 Credits (18 Credits for Core and 11 Credits for Elective Courses)						

ELECTIVES

Sl. No.	Course	Credit	Elective
1.	Sustainable Aquaculture	3	E
2.	Quality Assurance and Food Safety for Seafood Industry	3	E
3.	Management Accounting and Finance Management for Fisheries	3	E
4.	Seafood Side Stream Valorization	3	E
5.	Value addition of seafood (Practical)	1	E
6.	Quality Assurance and Seafood Microbiology (Practical)	1	E
7.	Case study on fishing gear design and operation	1	E
8.	Hatchery Techniques and Aquaculture Practices (Practical)	1	E

FOURTH SEMESTER

Course Code	Title of the Course	Credit	Core/ Elective	Marks		
				Continuous assessment	End Sem. Exam.	Total
24-308-0401	Analytics for Decision Making in Fisheries	3	C	50	50	100
24-308-0402	Dissertation/ Project Report Evaluation	8	C	100	-	100
24-308-0403	Course Viva-voce	1	C	-	100	100
24-308-0404	Elective-1	4	E	100	-	100
24-308-0405	Elective-2	1	E	100	-	100
24-308-0406	MOOC	2	E	-	100	100
Maximum Total Credit Offered in 4 th Semester: 19 (12 credits for Core and 7 credits for Electives)						

ELECTIVES

Sl. No.	Course	Credit	Elective
1.	Internship in Hatchery/Aquaculture farms/Aqua-industries	4	E
2.	Internship in Seafood Industry and Report Evaluation	4	E
3.	Start-ups and Business Incubation in Fisheries	1	E

TOTAL CREDITS OFFERED IN DIFFERENT SEMESTERS

	Maxi-mum Credits Offered	Semester 1	Semester 2	Semester 3	Semester 4	Total Credits
	CORE	24	18	18	12	72
	ELECTIVE	04	10	11	07	32
	TOTAL	28	28	29	19	104

TOTAL CREDITS OF BOTH ELECTIVES AND CORE PAPERS FOR THE AWARD OF THE DEGREE WILL BE ADJUSTED ACCORDING TO THE PROVISIONS IN THE CHOICE AND CREDIT BASED SYSTEM ADOPTED BY THE UNIVERSITY FROM TIME TO TIME.

FOR THE AWARD OF M.Sc. DEGREE IN INDUSTRIAL FISHERIES STUDENT SHALL ACQUIRE MINIMUM OF 104 CREDITS.

Students are free to select the Elective Courses offered by the School in a semester depending on their choices and the advice of the Student advisor

Students from other Departments/Schools of the University are also free to take the Elective/MOOC Courses offered in the School

SEMESTER 1

24-308-0101 TAXONOMY AND SYSTEMATICS OF COMMERCIALLY IMPORTANT FIN FISHES AND SHELL FISHES (3 Core)

Course Outcome (CO) : After completing the course, students will be able to

CO1- Identify major commercial and cultivable fish and shell fish.

CO2- Prepare dichotomous keys for fishes, crustaceans and molluscs

CO3- Apply the principles and rules of taxonomy and procedures for naming species

CO4- Identify species by ascertaining various names used currently and in past

CO5- Identify species used for export market and aquaculture quickly

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2
CO2	2	2	1	-
CO3	3	2	1	1
CO4	1	3	2	1
CO5	2	2	3	2

Module 1. Principles of taxonomy

Alpha, beta and gamma taxonomy. *Type concepts in fish taxonomy*– Binomial nomenclature- International Code of Nomenclature: principles and rules. Dichotomous keys. Synonyms and antonyms. Morphology- Description of species based on type specimen. Osteological keys- Cephalic bones- vertebrae. Morphometry and meristics- truss morphometry Methods of taxonomic data collection. Digital taxonomic information repositories – Fishbase, ITIS, WORMS, Catalogue of fishes, Sealifebase.

Module 2. Classification – Systematics. Phylogenetic studies

Introduction and concepts of phylogeny. Cladistics in taxonomy, cladogram, characters used for phylogeny reconstruction– phylogenetic tree.

Module 3. Classification of commercially important fishes

Characters of taxonomic value in respect of major families and species. Preparation of dichotomous keys

Module 4. Classification of commercially important crustaceans

Shrimps, prawns, crabs and lobsters. Characters of taxonomic value in respect of major families and species. Preparation of dichotomous keys. Classification of commercially important molluscs- bivalves, gastropods, cephalopods. Characters of taxonomic value in respect of major families and species. Preparation of dichotomous keys. Marine algae of commercial importance

Module 5. Modern taxonomic tools

Electrophoretic studies, Karyotyping, PCR, RAPD, RFLP, Microsatellites, mini satellites. Molecular markers – nuclear and mitochondrial DNA and their application in taxonomy – DNA barcoding- meta barcoding- eDNA.

Suggested Reading

- Cooksey, K. 1997. Molecular Approaches to the study of the oceans. Chapman and Hall, London, 549p.
- FAO. 2000. DNA Based Molecular Diagnostic Techniques.
- Jayaram, K.C. (2002) Fundamentals of fish taxonomy. Narendra Publishing House, 174p
- Kocher TD & Carol AS. (Ed.). 1997. Molecular Systematics of Fishes. Academic Press.
- Le Gal Y & Halvorson HO. 1998. New Development in Marine Biotechnology. Plenum Press.
- Mayer, E. 1977. Principle of systematic zoology, Tata McGraw Hill Publishing Co. Ltd. New Delhi, 428p.
- Moyle, P.B and J.C. Joseph Jr. 2000. Fishes – An Introduction to Ichthyology. 4th Ed. Prentice Hall, 612p.
- Munro, I. 1982. Marine and freshwater fishes of Ceylon, 349p.
- Nair, P.R. 2008. Biotechnology and Genetics in Fisheries and Aquaculture. Dominant Publ,
- Nelson 1990. Fishes of the world 308p.
- Ponniah AG & George J. 1998. Fish Chromosome Atlas. National Bureau of Fish Genetic Resources (NBFGR), Lucknow.
- Thomas D. Kocher and Carol A. Stepien (Ed.) 1997. Molecular systematics of Fishes. Academic Press. New York, 314p
- Whitmore DH. 1990. Electrophoretic and Isoelectric Focusing Techniques in Fisheries Management. CRC Press.
- Hewitt, G.M., Johnston, A. and Young, J.P.W. (Eds.) 1991. Molecular Techniques in Taxonomy, Springer-Verlag: 410 pp.
- Mayr, E. and Ashlock, P.D. 1991. Principles of Systematic Zoology. McGraw-Hill, New York: 475 pp.
- Quicke, Donald L.J. 1993. Principles and Techniques of Contemporary Taxonomy, Blackie Academic & Professional, London: 331 pp.
- Schuh, R. T. and Brower, A. V. Z. 2009. Biological Systematics: Principles and Applications (2nd edn.). Cornell University Press: 311 pp.
- Venkataraman K & C. Sivaperuman. 2014. Marine Faunal Diversity in India: Taxonomy, Ecology and Conservation. Academic Press 546 pp.
- Winston, Judith E. 1999. Describing Species: Practical Taxonomic Procedure for Biologists, Columbia University Press, New York

24-308-0102 FISHERY BIOLOGY (3 Core)

Course Outcome (CO) :

After completing the course, students will be able to

CO1- Identify and quantify the food and delineate feeding strategies of different fishes

CO2- Prepare feeding schedules suitable for fishes subjected to captive rearing

CO3- Advise resource management strategies by learning the trophic dynamics of fish resources

CO4- Identify reproductive status, maturity stages and reproductive potential of fishes

CO5- Estimate the age and growth of fishes using direct and indirect methods

CO6- Delineate migratory patterns of fishes

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2
CO2	2	2	2	1
CO3	2	2	1	-
CO4	3	3	2	-
CO5	3	2	2	-
CO6	3	3	3	-

Module 1. Food of different types of fin and shellfishes

Feeding types- filter feeders, carnivores, omnivores and their trophic levels -Morphological and anatomical adaptations for feeding; feeding behaviour of wild and cultured species. – Ontogeny changes in feeding- Forage theory- Mismatch hypothesis of Cushing.

Module 2. Techniques in the analysis of gut contents.

Feeding indices- simple and compound indices- index of relative importance- prey specific abundance. Diet breadth and niche breadth- feeding overlap studies- Assessment of mean trophic level and prey - predator relationship.

Module 3. Mode of reproduction

Asexual, sexual. Factors influencing reproduction- biotic and abiotic. Reproductive strategies and adaptations in fishes- hermaphroditism, sequential hermaphroditism- protandric, protogynic, gonochory, oviparity, ovoviviparity and viviparity - Reproductive cycles - Semelparity and iteroparity. Maturation- maturity stages - spawning periodicity - Size at first maturity. Fecundity- absolute- relative. Gonadosomatic index.

Module 4. Age and growth

Determination of age and growth- direct and indirect methods – Mark recapture studies - use of hard parts- scales, otoliths, length frequency analysis- Peterson method, modal progression analysis- VBGF- software used – ELEFAN- TrophFish R. Length-weight relationship- isometric and allometric growth. Fish mortality estimation- mortality rates.

Module 5. Migration:

Various types of spawning and feeding migrations- Fish tagging – different mark- recapture methods.

Suggested reading

- Adiyodi, K.G. and R.G. Adiyodi. 1971. *Endocrine Control of Reproduction in Decapod Crustacea*. Biology Reviews.
- Bal, D.V and K.V. Rao. 1990. Marine Fishes of India. 1st Revised Ed. Tata McGraw Hill
- Callucci, V.G., S.B. Saila, D.J. Gustafson and B.J. Rothschild, 1996. Stock Assessment. Quantitative methods and applications for small scale fisheries. Lewis publishers. Boca Raton, P. 527.
- Carl, E.B. 1979. *Biology of Fishes*. 2nd Ed. John Wiley & Sons.
- Cole, R.S. (2010) Reproduction and sexuality in marine fishes. Patterns and Processes. University of California Press, 409p
- Gulland, J.A. 1977. fish population dynamics. John Wiley and Sons. Chichester. P. 422.
- Gulland, J.A. 1992. A review of length based approaches to assessing fish stocks. FAO technical paper. 323. p.100.
- Hoar, W.S and D.J. Randall. (Ed.) 1969. *Fish Physiology*. Vol. III. Academic Press.
- Kurian, C.V and V.O. Sebastian .1986. Prawns and Prawn Fisheries of India. Hindustan Publ. Corp.
- Maria, J.R., Augustine, A. and B.G.Kapoor. 2006. *Fish Reproduction*. Science Publ.
- Moyle, P.B and J.C. Joseph Jr. 2000. Fishes – An Introduction to Ichthyology. 4th Ed. Prentice Hall, 612p.
- Nickolskhi, G.V. 1980. Theory of fish population dynamics. As the biological background for rational exploitation and management of fishery resources. science Publishers. P. 323.
- Nickolsky G.V (1999); *Ecology of fishes* Allied scientific Publishers p351
- Nikolsky, G.V. 2008. *The Ecology of Fishes*. Academic Press.
- Purchon (1968) *Biology of Molluscs* published by Pergamon press p 543
- Ricker, W.E. 1971. Methods for the assessment of fish production in freshwaters. Blackwell Scientific publishers, Oxford and IBH, Edinburg, 348p.
- Roch, M.J., Aukwe, A. and B.G.Kapoor (2008) Fish reproduction. Science Publishers. 653p
- Sparre, P. and S.C. Venema, 1998. Introduction to Tropical fish stock assessment Part. 1. Manual. FAO. Fisheries. Technical paper No: 301.; FAO Rome. p407.
- Venkataramanujam, K. and N. Ramanathan . 1994. *Manual of Finfish Biology*. Oxford & IBH.
- Wootton, R.J. and C. Smith (2015) Reproductive biology of teleost fishes. John Wiley & Sons 451p

24-308-0103 PRINCIPLES OF FISH HARVEST TECHNOLOGY (3 Core)

Course Outcome (CO) : After completing the course, students will be able to

CO1: Understand the classification systems on fish harvesting systems

CO2: Describe different materials available for fabrication of fishing vessels according to the requirements.

CO3: Compare and select different types of accessories to be used for fabricating different fishing gears

CO4: Apply the need of different fish harvesting methods according to the aquatic conditions

CO5: Apply the suitability of fishing craft and gear combinations in terms of technical specification and fishing conditions.

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	1	3	-
CO2	3	2	3	-
CO3	3	2	2	2
CO4	2	3	2	1
CO5	1	2	3	2

Module 1. Fishing Craft Materials

Introduction to Fishing Craft Technology –Boat building materials-wood, seasoning, treatment for boat building materials, marine plywood, steel, aluminium, ferro-cement and F.R.P. (G.R.P.). Merits and demerits of boat building materials. Low-cost substitutes for conventional boat building materials.

Module 2. Classification and Description of Fishing Vessels

Evolution of fishing crafts. Different types of fishing boats used in India. General arrangements of different types of fishing boats, trawler, seiner, longliner, combination vessels etc.

Terms and specifications of fishing vessels - Components of design parts and classification: Different structural elements- keel, transverse frames, longitudinal frames, web frames, vertical keelson, beams, girders, floors, brackets, pillars, stem bars, stern frames, bulkhead stiffeners, platings etc

Module 3. Classification and description of fishing gears

Trawl nets , Gill nets, Purse Seines, Long line, Troll lines, Hand line, Pole and line, Traps. Modern classification of fishing gears (FAO and A. Von Brandt). Indian classification fishing gears.

Module 4. Fishing Gear Materials.

Natural and synthetic fishing gear materials; Recent introductions in fishing gear materials; Biodegradable materials; Properties, Testing & Preservation of materials; Numbering systems-conversion formulae; Basic yarn types, Construction of twines and ropes– Synthetic Ropes, Steel wire ropes, Combination ropes.

Fishing gear accessories –Purpose and uses of various accessories. Floats for trawl, gillnets and seines. Estimating the buoyancy from the size of the Float. Estimation of the number of floats necessary for trawl, gillnet and seine.

Spherical floats and trawl floats. Floats (buoys) for marking nets, lines and traps.

Ground-rope leads and rings, leads for ropes, leads for lines, examples chains and thimbles- Accessories: shackles, links and clips, swivels, slip hooks and 'G' links, spreaders, cod-end release and purse rings,

Elements of trawl ground-ropes: steel bobbins, rigging a ground-rope with bunts, bobbins, spacers, rings or "cookies". Slings and tackles. Hooks: types, specifications. Baits: natural and artificial

Module 5. Mesh, Mesh Bar, Direction of netting

‘T’ direction ‘N’ direction. Types of netting., knotted netting, knot less netting, square mesh & hexagonal mesh netting. Type of knots- Trawl knot, double trawl knot & reef knot. Constructions of netting, Measurement of mesh strength. Selection of materials for different types of fishing gears.

Suggested Reading

- Brandt von, A. (1972). Fish Catching Methods of the World, Fishing News (Books)Ltd., Surrey, 240p.
- Brandt von, A. (1984) Fish Catching Methods of the World – 3rd edition, Fishing News Books, Osney, Mead, Oxford OX2 OEL, England, 418p.
- Chapelle, H. I. (1994). Boatbuilding: A Complete Handbook of Wooden Boat Construction, W.W. Norton, ISBN 0393035549, 624p.
- Coackley, N. (1991).Fishing Boat Construction: 2 Building a Fiberglass Fishing Boat, Issue 321 of FAO fisheries technical paper, FAO, ISBN 9251031169, 84p.
- FAO, (1975).FAO catalogue of small-scale fishing gear, Fishing News (Books) Ltd. Surrey, England, 191p.
- Fyson, J. (1985). Design of Small Fishing Vessels, Fishing News Books Ltd. Farnham, Surrey, England, 320p
- Fyson, J.F. (Ed). (1985). Design of small fishing vessels, Fishing News Books, Oxford.
- Klust, G. (1964). Netting twines of polypropylene and polyamide compared. In Modern Fishing Gear of the World 2, Fishing News (Books), Ltd., Surrey, England: 54p.
- Ponnambalam, A. (2003). Fishing Craft Technology.CIFNET. Cochin,158p.

- Pravin, P, Meenakumari B and Boopendranath M.R (2008). Harvest technologies for tuna and tuna like fishes in Indian seas and by catch issues. In Harvest and post-harvest technology for tuna (Joseph, J., Boopendranath, M.R., Sankar, T.V., Jeeva, J.C., and Kumar, R., Eds.), Society of Fisheries Technologists (India), Cochin-1-9: 79-103
- Richard O. N. Riley, Jeremy M. M. Turner (1995) Fishing Boat Construction: 3 Building a ferro-cement fishing boat, Volume 354 of FAO fisheries technical paper, FAO, ISBN 9251037647, 149p.
- Sainsbury, J. C. (1996). Commercial Fishing Methods- An Introduction to Vessels and Gears. Third Edition, Fishing News Books, Osney Mead, Oxford OX2 OEL, England: 359 p.
- Stokoe, E.A. (1985). Reed's Ship Construction for Marine Students, Volume 5 of Reed's Marine Engineering Series, Thomas Reed Publications, ISBN 0900335955, 192p.
- Shibu.A.V. (2017) Fishing Gear Materials Accessories and Design- Revised Second Edition (Publisher- Director, CIFNET, Govt. of India, Kochi -16, ISBN Number - 81-87245-16-6)
- Leela Edwin, Saly N Thomas, M. P Ramesan , P Mohammed Ashraf, M V Baiju, Manju Lakshmi N, and MadhuV. R (2019) Responsible Fishing: Recent advances in resource and energy conservation, Publ by Dr.Ravisankar C N, Director, ICAR Central Institute of Fisheries Technology, November 2019, 432p.
- Edwin L., Pravin, P., Madhu, V. R., Thomas, S. N., Ramesan, M. P., Baiju, M. V., Ravi, R., Das, D. P. H., 2014 Boopendranath M. R. and Meenakumari, B., (2014) Mechanised Marine Fishing Systems: India, Central Institute of Fisheries Technology, Cochin p225
- Meenakumari, B., Boopendranath, M.R., Pravin, P., Thomas, S.N. and Edwin, L. (2009) Handbook of Fishing Technology, Central Institute of Fisheries Technology, Cochin, 372 p

24-308-0104: FISH BIOCHEMISTRY (3 Core)

Course Outcome (CO) : After completing the course, students will be able to

CO1-Understand the significance of major and minor components in seafood

CO2-Analyze the nutritional requirement for different age groups and to differentiate the nutritional levels of various foods.

CO3-Evaluate the biochemical composition and the significance of seafood

CO4- Understand the mechanism of post mortem changes and fish spoilage.

CO5-Mechanism of post-mortem changes in fish and types of spoilage

CO6-Apply the knowledge of composition in fish preservation and storage

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1
CO2	3	2	2	1
CO3	3	3	2	2
CO4	3	3	2	2
CO5	3	3	2	2
CO6	3	3	2	2

Module 1: Biochemical composition of fish

Major and Minor components, Proximate Composition of fish- Water, Protein, Lipid and Minerals and vitamins in Fish. Non-Protein Nitrogenous compounds in Fish. Significance as quality and spoilage parameters. Fish muscle structure- Molecular organization of muscle –protein components of muscle cell- actin, myosin & actomyosin. Changes during muscle contraction.

Module 2: Fish Proteins and Fish lipids

Fractionation of fish proteins –Sarcoplasmic, myofibrillar & Stroma (connective tissue) proteins. Enzymes and their role in post mortem changes. Denaturation of proteins- Thermal and freeze denaturation of proteins. Functional properties of seafood proteins, texture profile of seafood proteins. Fish Lipids –Composition and nutritive value, lipid types and variations. Fatty acids, polyunsaturated fatty acids, essential and non-essential fatty acids Fatty acid composition of fish liver oils and body oils. Physiological activities of PUFA- Beneficial effects on human health Omega 3 fatty acids.

Module 3: Minerals, vitamins and Carbohydrates in Fish

Macro and trace elements in fish and shellfish - Minerals of nutritional significance. Fat soluble and Water Soluble Vitamins in fish and deficiency diseases. Carbohydrate in fish-

Glycogen composition in fish and shell fish. Nonprotein nitrogenous compounds in Fish: Free amino acids, Peptides, Nucleotides, Guanidins, Urea, Quarternary ammonium compounds, TMAO and its decomposition products, Nucleotides.

Module 4: Post mortem changes in Fish

Post mortem changes in Fish, Rigor mortis, significance in fish quality. Spoilage mechanisms in fish. Flavour changes in fish, Auto-oxidation of fatty acids and Rancidity. Biogenic amines. Mechanism of auto-oxidation. Factors affecting auto-oxidation, Antioxidant synergists and pro-oxidants.

Module 5: Spoilage of seafood

Classification of spoilage- Enzymatic, chemical and microbiological. Factors affecting fish spoilage, Spoilage characteristics of seafood, spoilage of fresh fish, crustaceans, molluscs. Spoilage of chilled and frozen seafoods. Microbial spoilage. Spoilage indices, Quality evaluation of fresh and spoiled fish and fishery products.

Suggested Readings:

- Gorge, M. P. and Barbec, W. T. 1990. Sea food: Effects of technology and nutrition. Marcel Dekker Inc., New York.
- J.J.Connel,1980. Advances in Fishery Science and Technology, Fishing News Books Ltd., England
- Joe, M. R. and Carrie, E. R. 1984. Food protein chemistry. Academic press Inc. New York.
- K. Gopakumar. Text Book of Fish Processing Technology., ICAR, New Delhi 12.
- Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry.
- Lehninger, A.L. 1984. Biochemistry, Kalyani Publishers, Ludhiana
- Michael Eskin N. A., 1990. Biochemistry of foods. Academic Press Inc., New York.
- Owen, R. F. 1996. Food chemistry. Marcel Dekker, Inc., New York.

24-308-0105 MANAGERIAL ECONOMICS (4 Core)

Course Outcome (CO) : After completing the course, students will be able to

- CO1. *Gain theoretical understanding about the foundations of managerial Economics.*
- CO2. *Distinguish between law of demand and law of supply and determination of market equilibrium price.*
- CO3. *Estimate elasticity of demand and supply to determine the optimal price-quantity combination to maximize revenues and profits.*
- CO4. *Analyze production and costs in the short and long run.*
- CO5- *Analyze the optimal quantity and pricing decisions of alternative market structures to achieve profit maximization.*
- CO6. *Apply the theoretical knowledge about the Managerial Economics into practical situations.*

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3
CO2	3	2	2	2
CO3	3	3	3	3
CO4	3	2	3	2
CO5	3	3	3	3
CO6	3	2	2	2

Module 1. Introduction to Managerial Economics

Characteristics of Managerial Economics – Nature, Scope, and Methodology of Managerial Economics, Basic Economic Tools in Managerial Economics- Managerial Decision Making and Economic Theory, Goals of the firm: Measuring and Maximising Economic Profit, Economic Cost of Using Resources, Economic Profit versus Accounting Profit, Other Goals Forms of Business Organisation, Separation of Ownership and Control.

Module 2. Demand and Supply Analysis

Demand Functions - Law of Demand, Violations of the Law of Demand, Shifts in Demand; Elasticity of Demand: Demand- Determinants, Computation and relation to total revenue, Price Elasticity of demand, Factors affecting price elasticity of demand,

Income Elasticity, Cross Elasticity. Law of supply, elasticity of supply, market equilibrium, changes in equilibrium.

Module 3. Production and Cost Analysis

Production Function, Short Run and Long Run, Law of Variable proportions, Laws of Returns to Scale, Economies of Scale, Expansion Path, Cost of Production, Fixed and Variable Costs, Relationship between Average and Marginal Cost, Long run cost curves, Relationship between LAC and SAC, Modern Theory of Cost.

Module 4. Managerial Decision Making under Alternative Market Structures

Characteristics of Market Forms, Profit Maximisation, Price and Output in Competitive Markets, Break Even Point, Shut Down Point. Price Discrimination under Monopoly, Profit Maximisation, Output and Pricing Decisions under Monopoly and monopolistic competition. Oligopoly, Interdependence of strategic decision making, Collusive and non- collusive oligopoly.

Module 5. Pricing Decisions

Pricing decisions under Risk and Uncertainty, Pricing of new products, Penetration pricing, Skimming pricing, Average Cost Pricing, Marginal cost pricing, Peak Load Pricing, Limit Pricing, Multiproduct Pricing, and Transfer Pricing. Externalities and Market Failure- The Principal - Agent Problem, Asymmetric Information, Moral Hazard and Adverse Selection, Understanding externalities and market failures, pricing under market failure.

Suggested Reading

- Allen, W. B. 2009. Managerial Economics Theory, Applications, and Cases, 7th Edition. Norton.
- Baye, Michael. Managerial Economics and Business Strategy.9th Edition. Boston: McGraw-Hill Irwin, (2017).
- D.M. Mithani, Managerial Economics, 5/e, Himalaya Publishing House, Mumbai.
- Damodaran Suma (2010) Managerial Economics, Oxford University Press
- Gupta, G.S. 2011. Managerial Economics. McGraw Hill Education (India) Private Limited.
- Geethika, Ghosh & Choudhury, Managerial Economics, 2/e, McGraw Hill.
- Hirschey, M. 2009. Fundamentals of Managerial Economics, Cengage Learning.
- James, A Pappas and Mark Hirschey, Fundamental of Managerial Economics, The Dryden Press.
- Jhingan, M.L. and Stephen, J.K. 2014. Managerial Economics. 2nd Edtn. Vrinda Publications P Ltd.
- Keat, P. and Young, P.K. 2013. Managerial Economics, 7th Edtn. Prentice Hall.
- Koutsoyiannis, Modern Micro Economics, 2/e, Macmillan Press Ltd
- Kumar, A and Sharma, R. 1998. Managerial Economics. Atlantic Publishers and Distributors, New Delhi.

Maheshwari K. L. and Varshney R.L. 2014. Managerial Economics, 22nd Revised Edition, Sultan Chand & Sons.
 Salvatore, D. 2014. Managerial Economics in a Global Economy. Oxford University Press 8th edition.
 Samuelson, W.F. and Marks, S.G. 2011. Managerial Economics. 7th edition. John Wiley & Sons.
 Yogesh, Maheswari, Management Economics, PHI learning, New Delhi

24-308-0106 PRINCIPLES OF FISH BUSINESS MANAGEMENT (4 Core)

Course Outcome (CO) : After completing the course, students will be able to

CO1-Understand the management functions applicable in fish business management
CO2- Understand concepts of individual, interpersonal and organisational processes for managing organisations
CO3-Apply the tools and techniques of management and organisational processes in managerial decision making
CO4- Analyse the challenges and constraints for management functions in fish business
CO5-Evaluate the management strategies in different fish businesses

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	-	3	3
CO2	1	1	1	3
CO3	3	1	1	3
CO4	3	3	3	3
CO5	3	3	2	2

Module 1: Introduction to fish business

Introduction to Fish business management- Types of fish businesses- Fish capture and culture business, domestic and export seafood business, seafood and allied business. Management process, Role of a manager in business- Management and administration, Individual processes- Perception, Concepts and theories, Perception and Decision Making, Learning and Learning Theories, Motivation- Motivation Theories, Personality Concepts- Theories of Personality – Personality testing and applications in organizations

Module 2: Functions of management-Planning –Steps involved in Planning – Classification of Plans-Strategic Planning- SWOT analysis and Operational Planning Process of Managing by Objectives (MBO) – Strategies, Policies & Planning Premises

Module 3: Organising

Formal and informal organization – Organization Chart – Structure and Process – Departmentalizing by difference strategies –Line and Staff authority – De-Centralization and Delegation of Authority – Staffing – Selection Process - Techniques – HRD – Managerial Effectiveness.

Module 4. Directing

Directing – Group Dynamics -Understanding Groups and Teams, Types of Teams- Team Performance- Process of Group Formation, Interpersonal processes-Leadership, Leadership styles and Leadership Theories, Interpersonal communication- - Interpersonal Communication-Conflict and conflict management, Stress and negotiation-Decision Making, Organisational Processes- Decision making, Job design and Job Enriching, Organisation Design, Organisation culture, Organisation change

Module 5. Controlling

Controlling as a management function, Performance Appraisal, System and process of Controlling – Requirements for effective control – Productivity – Reporting

Suggested Reading

Fred Luthans (2010). *Organizational Behaviour*. New York: McGraw-Hill.
Harold Koontz(2010). *Essentials of Management*. New Delhi: Tata McGraw-Hill Education.
Stoner, Freeman & Gilbert Jr. (2009). *Management*. New Delhi: Prentice Hall.
Wehrich, H. & Koontz, H. (2010). *Management- A Global Perspective*: New Delhi: Tata McGraw-Hill Education.
Robbins & Coulter (2013). *Management*. New Delhi: Prentice Hall.
Robbins, S.P. & Decenzo, D. A. (2014). *Fundamentals of Management: Essential Concepts and Applications*. New Delhi: Pearson Education.
Schermerhorn, J.R Management for Productivity, 1984. (Wiley Series in Management)

**24-308-0107 RESEARCH METHODOLOGY AND QUANTITATIVE
TECHNIQUES FOR FISHERIES (4 Core)**

Course Outcome (CO) : After completing the course, students will be able to

- CO 1. Understand the scientific methods and its application to research in industrial fisheries, enabling them to critically evaluate research studies and design their own.*
- CO 2. Understand the research design and various sampling techniques and to comprehend the role of research in advancing and sustaining industrial fisheries practices.*
- CO 3. Apply their understanding of different data collection methods to demonstrate the ability to match research questions and objectives with suitable methodologies in industrial fisheries contexts.*
- CO 4. Analyze the data using different analytical tools for meaningful decision making*
- CO 5. Apply different reporting and presentation styles to disseminate research findings.*

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1
CO2	3	1	1	-
CO3	3	2	2	1
CO4	3	3	2	2
CO5	1	3	3	3

Module 1: Introduction to Research Methodology

Understanding the scientific method Importance of research in industrial fisheries. Types of research (basic, applied, quantitative, qualitative) Formulating research questions and objectives. Modern methods for reviewing the literature. Ethical considerations in research

Module 2: Research Design and Sampling Techniques

Principles of research design. Experimental vs. observational studies. Cross-sectional, longitudinal, and case-control studies. Sampling techniques in fisheries research. Sample size determination and power analysis. Bias and error in sampling

Module 3: Data Collection Methods

Primary vs. secondary data Techniques for collecting primary data in fisheries research (surveys, interviews, observations). Instrument development and validation (questionnaires, scales). Remote sensing and GIS applications in fisheries research. Data logging and telemetry. Ethnographic methods in fisheries research

Module 4: Data Analysis and Interpretation

Introduction to statistical analysis. Descriptive statistics (mean, median, mode, variability). Inferential statistics (parametric vs. non-parametric tests). Hypothesis testing and confidence intervals.

Module 5: Reporting and Presenting Research Findings

Structure of a research report (title, abstract, introduction, methods, results, discussion, conclusion, references). Writing styles and formatting guidelines. Effective data visualization techniques (Infographics, graphs, charts, tables). Oral presentation skills and public speaking tips. Peer review process and publication ethics. The role of scientific conferences and journals in disseminating research findings.

Suggested Reading

Research Methodology: A Step-by-Step Guide for Beginners" by Ranjit Kumar, 4th edition, SAGE

Research Methods in Fisheries Science" by Paul J. B. Hart and John D, 1st Edition, Wiley-Blackwell

"Research Design: Qualitative, Quantitative, and Mixed Methods Approaches" by John W. Creswell and J. David Creswell, 3rd Edition, SAGE.

Statistical Methods for Research: A Step by Step Approach Using IBM SPSS. K Kalyanaraman, 1st Edition. ATLANTIC

Experimental and Quasi-Experimental Designs for Generalized Causal Inference" by Donald T. Campbell and Julian C. Stanley. Wadsworth Publishing

ELECTIVES

1. INTRODUCTION TO FISHERIES INDUSTRY AND INSTITUTIONS (2 Credits)

Course Outcome (CO) : After completing the course, students will be able to

CO1-Understand the significance of fisheries sector

CO2-Understand the roles and responsibilities of fisheries industries

CO3-Understand the seafood processing industry and employment opportunities in the sector

CO4-Understand the mandates and responsibilities of International and national fisheries institutions

CO5-Apply the knowledge in fisheries learning and career development.

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1
CO2	2	2	2	1
CO3	2	1	2	2
CO4	2	-	1	1
CO5	1	1	1	1

Module 1: Overview of global fisheries.

Status of world fisheries and aquaculture. World fisheries statistics. Importance of seafood in global food trade. United Nations Sustainable Development Goals (SDGs). Terminologies related to fish and fisheries.

Module 2: Introduction to Indian fisheries.

Capture and culture fisheries in India. Contribution of fisheries to the Indian economy, agriculture GDP etc. Maritime states, Indian fisheries statistics. Major commercial fin fishes and shell fishes. Major harvesting systems. Major and minor harbors.

Module 3: Introduction to the seafood industry.

Global seafood markets. Major export items. Seafood export statistics from India. Seafood processing plants in India. Capacity fixation & utilization. Major challenges in seafood export from India. Organizational structure of the seafood industry. Job opportunities and job profile of post graduates in the fisheries industry and fisheries institutions.

Module 4: Global fisheries related organizations; FAO, IMO, ILO, IMF, World Bank, ICLARM, BOBP, IOTC, NOAA, NMFS, WAS, OCPP etc. Role, responsibilities and contributions of international organizations.

Module 5: Indian fisheries organizations; Central Government organizations under various ministries- NFDB, FSI, CIFNET, CICEF, NIFPHATT; EIC, MPEDA, NIOT, INCOIS, NIO, Coastal Aquaculture Authority etc. State government institutions/departments- Dept. of fisheries, MATSYAFED, BENFISH, MFDC, TNFDC, KFDC, FIRMA, ADAK, Fund board etc. R&D institutions-Indian Council for Agricultural Research (ICAR), CMFRI, CIFT, CIFE, CIFRI, CIBA, CIFA, NBFGR, DCFR. Fisheries Educational institutions & Universities.

Suggested Readings;

Food and Agriculture Organization website, Technical papers etc

Status of World Fisheries and Aquaculture published by FAO

Annual reports of CMFRI, MPEDA, CIFT etc

Indian Fisheries- Issues and the Way Forward, S Ayyappan, 2012. National Academy Science letters 35 (1).

Indian Council of Agricultural Research website, publications

2. ENTREPRENEURSHIP DEVELOPMENT IN FISHERIES (2 Credits)

Course Outcome (CO) : After completing the course, students will be able to

CO1-Understand the entrepreneurial concepts and principles relevant to the fisheries sector, including identifying opportunities, assessing risks, and creating value through innovative business ventures.

CO2-Apply techniques to create appealing business plans

CO3-Analyse various funding opportunities and to select one which is most suitable for the venture

CO4-Understand about social entrepreneurship and the importance of social entrepreneurship in addressing social and environmental challenges.

CO 5. Understand the legal and regulatory framework governing fisheries businesses

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	3
CO2	3	3	2	3
CO3	2	2	2	2
CO4	1	1	1	3
CO5	3	3	2	2

Module 1: Introduction to Entrepreneurship in Fisheries

Overview of entrepreneurship in the fisheries sector. Importance and role of entrepreneurship in fisheries development. Historical perspective and evolution of entrepreneurial activities in fisheries. Entrepreneurial opportunities and challenges in the fisheries industry. Government policies and initiatives supporting entrepreneurship in fisheries

Module 2: Business Planning and Management in Fisheries

Concept and components of a business plan in fisheries entrepreneurship. Market analysis and identification of market opportunities in fisheries. Financial planning and management for fisheries ventures. Operations management and supply chain considerations in fisheries enterprises. Risk assessment and mitigation strategies for fisheries businesses. Market Research, Competitor Analysis, Product analysis.

Module 3: Funding Opportunities for Entrepreneurs

Overview of the funding landscape in India. Importance of funding for entrepreneurial ventures. Types of funding sources: equity, debt, grants, and subsidies. Introduction to government schemes and initiatives supporting entrepreneurship. Overview of bank loans

and debt financing options for entrepreneurs. Types of bank loans available for start-ups and SMEs. Eligibility criteria and documentation requirements for obtaining bank loans. Alternative forms of debt financing: peer-to-peer lending, invoice financing, and microfinance

Module 4: Social Entrepreneurship

Definition and characteristics of social entrepreneurship. Importance of social entrepreneurship in addressing social and environmental challenges. Distinction between traditional entrepreneurship and social entrepreneurship. Case studies of successful social entrepreneurial ventures in fisheries and environmental conservation. Models of social enterprises focusing on sustainable fisheries management, marine conservation, and ecosystem restoration. Examples of social entrepreneurship initiatives promoting community-based fisheries management and marine protected areas

Module 5: Legal Compliance in Fisheries Entrepreneurship

Overview of the legal and regulatory framework governing fisheries businesses. Importance of legal compliance for starting and operating a fisheries-based venture. Key regulatory bodies and agencies responsible for overseeing fisheries laws and regulations. Procedures for registering a fisheries-based business entity (e.g., sole proprietorship, partnership, private limited company). Obtaining necessary permits, licenses, and approvals from regulatory authorities (e.g., fisheries department, pollution control board). Compliance with tax laws, GST registration, and other statutory requirements for business operations.

Suggested Reading

"India Startup Ecosystem: The Complete Roadmap" by Startup India - This comprehensive guide offers an overview of the startup ecosystem in India, including funding options, support networks, and government initiatives aimed at fostering entrepreneurship.

"Stay Hungry Stay Foolish" by Rashmi Bansal - This book profiles the journeys of 25 entrepreneurs in India, offering inspiring stories and insights into the challenges and opportunities of entrepreneurship in the country.

"Made in India: The Story of India's 'Unicorn' Startups" by Akshay Sharma - This book profiles some of India's most successful startups, offering insights into their business models, strategies, and the factors contributing to their success.

Entrepreneurship Opportunities in Fisheries and Aquaculture by Bimal P Mohanty (Author), Shahaji Phand (Author), Sushrrekha Das (Author). *Entrepreneurship Opportunities in Fisheries and Aquaculture in India” has been designed. The different sub-sectors including hatchery for fish breeding and culture, cage farming, pen culture, fish feed, ornamental fish and aquarium industry, dry-fish and fish processing sector, pearl culture, mariculture, aquaponics, fishing crafts and gears, sports fisheries and aqua-tourism, where there is a scope for entrepreneurial venture have been discussed.*

The New Fish Wave: How to Ignite the Seafood Industry by Thor Sigfusson. *The New Fish Wave describes how the Iceland Ocean Cluster has inspired more innovation and entrepreneurship in the global seafood industry: doing more with less to create value from fish byproducts and to build sustainable global fisheries.*

3. FISH TAXONOMY & BIOLOGY- (Practical) (1 Credit)

Course Outcome (CO) : After completing the course, students will be able to

CO1- Understand the status of capture fisheries and species diversity

CO2- Develop identification skills for the commercial important finfishes and shellfishes

CO3- Understand the feed and feeding habitat of commercially important fishes

CO4- Identify reproductive status, maturity stages and reproductive potential of fishes

CO5- To learn the recent methodologies of sustainable exploitation of renewable resources.

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1
CO2	3	2	1	-
CO3	3	3	1	2
CO4	2	2	1	2
CO5	3	3	2	2

Module 1. Field visit to fish landing centers and fishing harbours.

Collection of commercially important fishes, crustaceans and molluscs.

Module 2. Identification of finfishes and shellfishes of importance in capture fisheries and aquaculture using standard keys

Module 3. Preparation of dichotomous keys for major finfish and shellfish

Module 4. Analysis of gut contents. Estimates of feeding indices – simple and compound indices

Module 5. Identification of spawning season, maturity stages, estimation of gonadosomatic index, Estimation of fecundity

Estimation of growth- Length weight relationship- isometric and allometric growth- VBGF
– Mortality rates- Exploitation rate

Suggested readings

- Adiyodi KG & Adiyodi RG. 2000. Reproductive Biology of Invertebrates: Vol. X. Part B. Progress in Developmental Endocrinology. John Wiley & Sons.
- Agarwal NK. 1996. Fish Reproduction. APH Publ. Corp.
- Bal, D.V and Rao, K.V. 1990. Marine Fishes of India. 1st Revised Ed. Tata McGraw Hill, 472p.
- Bone Q, Marshall NB & Blaxter JHS. 1995. Biology of Fishes. 2nd Ed. Blackie.
- Carl EB. 1979. Biology of Fishes. 2nd Ed. John Wiley & Sons.
- Hoar WS & Randall DJ. (Ed.) 1969. Fish Physiology. Vol. III. Academic Press.
- Jobling M. 1995. Environmental Biology of Fishes. Chapman & Hall.
- Kurian, C.V and Sebastian V.O. 1986. Prawns and Prawn Fisheries of India. Hindustan Publ. Corp, p, 296.
- Khanna SS. 1993. An Introduction to Fishes. Central Book Depot.
- Mayer, E. 1977. Principle of systematic zoology, Tata McGraw Hill Publishing Co. Ltd. New Delhi, 428p.
- Munro, I. 1982. Marine and freshwater fishes of Ceylon, 349p.
- Nikolsky GV. 1983. Fisheries Biology. Academic Press.
- Saxena AB. 1996. Life of Crustaceans. Recent Advance in Entomology Series-10. Anmol Publ.
- Venkataramanujam K & Ramanathan, N. 1994. Manual of Finfish Biology. Oxford & IBH.
- Ponniah AG & George J. 1998. Fish Chromosome Atlas. National Bureau of Fish Genetic Resources (NBFGR), Lucknow

4. FISH BIOCHEMISTRY (Practical) (1 credit)

Course Outcome (CO) : After completing the course, students will be able to

CO1. Understand the basic principles of food chemistry and fish biochemistry

CO2. Understand the working of laboratory equipments and instruments

CO3. Apply the knowledge of fish analysis in qualitative and quantitative measurements

CO4. Evaluate the proximate composition of foods particularly the seafood

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3
CO2	3	3	3	3
CO3	3	2	3	2

CO4	3	3	1	2
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Module 1: Basic laboratory safety and hygiene protocols.

Overview of food analysis methods: qualitative and quantitative. Principles of sample preparation and extraction.

Module 2. Introduction to laboratory instruments and instrumental analysis techniques:

Basic Principles of Colorimetry, Spectrophotometry and Chromatography.

Module 3: Proximate Analysis of Food-

Determination of moisture content by oven drying method. Extraction and quantification of fat content by Soxhlet extraction methods. Protein determination by Kjeldahl method and colourimetry methods. Determination of ash content by dry ashing method. Calculation of carbohydrate content. Proximate analysis of fish and shell fish- moisture, ash, fat and protein.

Module 4: Basic experiments in Biochemistry.

Estimation of Glucose, Glycogen, free amino acids and soluble proteins in fish samples .

Module 5. Determination of fat constants:

Saponification Value, Iodine Value and Acid Value. Estimation of FFA value, Peroxide Value and TBA Value as indices of rancidity.

Suggested Reading

AOAC 2012. Official Methods of Analysis of AOAC international

Eskin M.N. A. 1990. Biochemistry of foods. Academic Press Inc., New York.

Fennemma. O.L. Principles of Food Sciences Part 1 Marcel Decker, INC, New York

Owen, R. F. 1996. Food chemistry. Marcel Dekker, Inc., New York.

Robert, G. A. 1989. Marine, Biogenic Lipids Fats and oils Vol. II CRC Press Inc., Boca Raton, Florida.

Roy, E. M., Geroge, J. F. and Donn, R. W. 1982. Chemistry and Biochemistry of marine food products. AVI publishing company, Westport, Connecticut.

Smith, W.H., 1973. Principles of Biochemistry, 5th edition, McGraw Hill, Kogkusha Ltd., Sydney

Wilson K. and J. Walker, Principles and Techniques of Practical Biochemistry. Cambridge University Press, Medical. 784p

SEMESTER-II

24-308-0201 FISHERIES RESOURCES MANAGEMENT (3 Core)

Course Outcome (CO) : After completing the course, students will be able to

CO1- To understand major capture fisheries in the world, landing pattern and resource availability of species having demand in overseas markets.

CO2- To know the present level of exploitation of marine resources and to impart knowledge on conservation measures.

CO3- To learn the recent methodologies of sustainable exploitation of renewable resources.

CO4- To understand the application of various models to estimate fish stock size from time to time

CO5- To regulate various forces acting on the fish population for improving sustainability

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2
CO2	3	3	2	2
CO3	2	2	2	1
CO4	3	3	3	2
CO5	2	2	3	1

Module 1 World capture fisheries production and consumption patterns.

The major fishing nations of the world, major fishing regions, the present trend of Marine capture fisheries. Major species of fin and shellfishes constituting fishery, landing trends and status of fish stocks. Employment opportunities in the fisheries sector. Major ocean process affecting marine fish production -Enso, El Nino and La Nino cycles. Mudbank, upwelling and ocean circulation.

Module 2 Exclusive Economic Zone (EEZ) of India

fishing zones and their important resources. Important fishing grounds-Profile of Indian marine Fisheries-length of the coast, areas of EEZ and continental shelf, maritime states and Union territories and their status in fish landings. Infrastructure and employment status in marine fisheries of India

Module 3: Important finfish and shellfish resources

Pelagic and demersal realms of Indian EEZ. Exploited fisheries of sardines, anchovies, mackerel, ribbon fishes, tuna, seer fishes, carangids, elasmobranchs, Bombay duck,

catfishes, silver bellies, sciaenid, threadfins, perches, flatfishes, shrimps, crabs, lobsters, mussels, oysters, clams, chanks, cephalopods, carps. Inland Fisheries of India: Estuarine and brackish water fisheries of India: Major estuaries and backwaters: Chilka, Pulicat, Vembanad, Hooghly-Matlah, Godavari, Hilsa etc.

The fishery of shrimps, mullets, milkfish, Pearlsport, Bhekti, Indian salmon, catfishes and perches Major rivers, reservoirs, and their fishery. The fishery of carps, catfishes, mahseer, trouts, hilsa, and freshwater prawns. Impact of climate change on fisheries-SST, sea-level rise, ocean acidification, ocean warming and biological productivity, Harmful algal blooms

Module 4 Stock Assessment:

Concept of unit stock, Age and growth estimation, length-weight relation and its application in population dynamics. Estimation of growth parameters and mortality rates, Fish stock assessment- Macro analytical models - Surplus model- MSY- Swept area method- Box model–Stochastic model. Gear selectivity Overfishing-Growth, Recruitment and Ecosystem. Yield per recruit on analysis –Thompson and Bell analysis.

Stock recruitment relationship – Stochastic model – estimation of technical reference point MSY and other yield base reference point. Ecosystem-based fisheries management- Eco path- Ecosim. Fisheries management strategies- Multispecies fisheries management.

Module 5 Marine fisheries Regulation Act (MFRA) in various States of India

Fisheries regulatory and developmental setup in Centre and States and their Spheres of responsibility as per the constitution Monitoring, Control and Surveillance (MCS) systems for capture fisheries: definition; components; role and importance in fisheries management.

Maritime Zones of India Act 1981 (Regulation of fishing by Foreign vessels). Draft Marine Fisheries Policies. International Law of the Sea: Historical perspectives; international negotiations and settlements over open seas; conflict management; shared stocks. FAO Code of Conduct for Responsible Fishing.

Suggested Reading

- Bal, D.V., and Rao, K.V. 1990. Marine Fishes of India.1st Revised Ed.New Delhi Tata-McGraw Hill. 265p.
- Belgrano, A. and C.W. Fowler (2011) Ecosystem based management for marine fisheries an evolving perspective Cambridge university press 388p
- Beverton RJH & Holt SJ. 2004. On the Dynamics of Exploited Fish Population.The Blackburn Press.
- Chandra, P. 2007. Fishery Conservation, Management and Development. SBS Publ. 655p

- Churchill, R.R and A.V. Lowe .1988.Law of the Sea.Manchester University Press. 370p
- Clark, J.R. 1992. Integrated Management of Coastal Zones. FAO Fisheries Tech. Paper No. 327, Rome. 720p
- David, S. and P. Jeremy. 2001. Inshore Fisheries Management. Methods and Technologies in Fish Biology and Fisheries. Vol. II. Kluwer. 432p
- Dholakia, A.D. 2004. Fisheries and Aquatic Resources of India. Daya Publ. House. 413p.
- Edwards EF & Megrey BA. 1989. Mathematical Analysis of Fish Stock Dynamics. American Fisheries Society, Maryland.
- FAO. 1996. Fishing Operations. FAO Training Guidelines for Responsible Fisheries.No. 1. Rome. 20p
- FAO. 2003. Fisheries Management. The Ecosystem Approach to Fisheries.
- Gulland JA. (Ed.). 1977. Fish Population Dynamics. John Wiley & Sons.
- Hamlisch, R. 1988. Methodology and guidelines for fisheries development planning with special reference to developing countries, FAO Fisheries Technical Paper No.297 FAO, Rome
- ICAR. 2011. Handbook of Fisheries and Aquaculture. ICAR. 850p.
- Jhingran V.G and K.L. Sehgal.1978.Cold Water Fisheries of India. J. Inland. Fish.Soc. India. Sp. Publ.
- Jhingran V.G. 1991. Fish and Fisheries of India. 3rd Ed. Hindustan Publ. 231p
- John R.Clark, 1992. Integrated Management of Coastal Zones, FAO
- Kevin Cream and David Symes (Ed) 1996.Fisheries Management in crisis, Fishing News
- Koers, A. M. 1973. International Regulations of Marine Fisheries A study of regional fisheries organizations, Fishing News Books Ltd, England
- Korakandy, R.1996. Economics of Fisheries Management A critique in Third World
- Kurian C.V. and V.O. Sebastian. 1986. Prawns and Prawn Fisheries of India. Hindustan Publ. Corp. 270p
- Kurup, B.M, Radhika Rajasree and S. Venu (2008). Distribution of deep sea prawns off Kerala, *Journal of Marine Biological Association of India* 50(2): 122-126.
- Kurup, B.M. and M. Harikrishnan (2000).Reviving the *Macrobrachium rosenbergii* (de Man) fishery in Vembanand Lake, India.*Naga, The ICLARM Quarterly* 23(2): April – June 4-9
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24-308-0202 DESIGN AND CONSTRUCTION OF FISH HARVESTING SYSTEMS (3 Core)

Course Outcome (CO) : After completing the course, students will be able to

CO1: Describe design drawing and mould-lofting of fishing crafts

CO2: Identify and demonstrate working principles of marine engines, operation and maintenance of engines and associated systems.

CO3: Describe selection of design and testing of different types of fishing gears

CO4: Develop methods to analyse selectivity of different fishing gears that will answer the specific questions on resource conservation

CO5: Analyse the fish response for design development and optimisation of fishing gears.

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	2	1	3	-
CO2	2	3	3	1
CO3	2	3	3	-
CO4	3	2	3	1
CO5	3	2	2	2

Module 1.Design Concepts of Fishing Crafts

Fishing Craft Specifications and Dimensions -Determination of main dimensions. Estimation of component weights.

Development of lines Profile view – Half breadth plan – Body plan – Mould lofting – off-set table – template. Rules and regulations for fishing boat construction.

Module 2. Marine engines and Propulsion Systems

Working principles of internal combustion engines cycle of operation Marine Engine – 2 stroke and 4 stroke engine – Petrol and diesel engine – various parts of engine and their functioning

Fuel system – Lubrication oil system – Cooling system – starting system- supercharging system

Consideration in selection of engine for fishing boats – Maintenance of engine and fishing boat.

Different propulsion system – outboard motors –inboard/outboard drive – variable pitch propeller

Module 3. Basic Principles of fishing gear designs

Methods to develop new gear designs. Shaping - *baiting, creasing and tailoring; Cutting ratio calculations, Hanging co-efficient,*

Assembling Seaming, Mounting, Estimation of Webbing requirements. Fishing gear selectivity and fish response to gear systems - Trawl selectivity, Gillnet selectivity, Hook selectivity. Response of fish to fishing gears and systems – Moving gear, Stationary gear.

Module 4. Designs and construction of commercial fishing gears.

Methods to develop new gear designs. Methods of testing fishing gear.

Design of trawl nets; Size of trawl for the power of the vessel, BHP, ANP. Relationship between mesh size and twine size for bottom trawls, midwater trawls.

Otter boards: their design, functions and construction; Selection of otterboard; Estimating the spread of otter boards (doors), Selection of otterboard with power of vessel,

Design of gill nets: Choice of mesh size according to fish Species, Choosing twine type for gillnets, Choosing twine diameter for Gillnets. Rigging or hanging gillnets, Effect of the hanging ratio on the catching efficiency of the net. Trammel nets: mesh sizes and rigging of trammel net.

Design of purse seines: Minimum length and depth of the purse seine, size of the bunt. Choice of mesh size, Relationship between the diameter of the twine and mesh size, Significance of hanging ratio.

Design of lines: Design of Pole and Line, Troll line, Long line, Hand lines and Squid jigs.

Module 5. Fish behaviour studies and design development of fishing gears

Key stimuli influencing fish response- vision, olfactory, hearing, lateral line etc. Fish response to commercial fishing gears, Methods and techniques for studying fish response in the natural environment.

Suggested Reading

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Coackley, N. (1991) Fishing Boat Construction: 2 Building a Fiberglass Fishing Boat, Issue 321 of FAO fisheries technical paper, FAO, ISBN 9251031169, 84p. 33

FAO (1974) Otter board Design and Performance, FAO Fishing Manuals, FAO of UN, 79 p.

FAO (1975) FAO catalogue of small-scale fishing gear, Fishing News (Books) Ltd., Surrey, England, 191p.

FAO (1995) Code of conduct for responsible fisheries, FAO, Rome, 41p.

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Fyson, J. (1985) Design of Small Fishing Vessels, Fishing News Books Ltd. Farnham, Surrey,

England, 320p

Fyson, J.F. (ed). (1985). Design of small fishing vessels, Fishing News Books, Oxford.

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Leela Edwin, Saly N Thomas, M. P Ramesan , P Mohammed Ashraf, M V Baiju, Manju Lakshmi N, and Madhu R (2019) Responsible Fishing: Recent advances in resource and energy conservation, Publ by Dr.Ravisankar C N, Director, ICAR Central Institute of Fisheries Technology, November2019, 432p.

Marine Corrosion: Causes and Prevention (1985) FL LaQue- John wiley& Sons, New York, USA.

Ponnambalam, A., (2003). Fishing Craft Technology.CIFNET. Cochin:158p.

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Pravin, P, Meenakumari, B. and Boopendranath, M.R. (2008). Harvest technologies for tuna and tuna like fishes in Indian seas and by catch issues. In Harvest and post harvest technology for tuna (Joseph, J., Richard O. N. Riley, Jeremy M. M. Turner (1995) Fishing Boat Construction: 3 Building a ferrocement fishing boat, Volume 354 of FAO fisheries technical paper, FAO, ISBN 9251037647, 149p.

Sainsbury, J. C. (1996) Commercial Fishing Methods- An Introduction to Vessels and Gears. Third Edition, Fishing News Books, Osney Mead, Oxford OX2 OEL, England: 359 p.

ShahulHameed, M. and Boopendranath, M. R. (2000). Modern fishing Gears of the world, Diya publication house, New Delhi.

Shibu.A.V. (2017) Fishing Gear Materials Accessories and Design- Revised Second Edition (Publisher- Director, CIFNET, Govt. of India, Kochi -16, ISBN Number - 81-87245-16-6)

Stokoe, E.A. (1985) Reed's Ship Construction for Marine Students, Volume 5 of Reed's Marine Engineering Series, Thomas Reed Publications, ISBN 0900335955, 192p.

24-308-0203 CHILLING AND FREEZING TECHNOLOGY OF FISH (2 Core)

Course Outcome (CO) : After completing the course, students will be able to

CO1-Understand the importance of seafood preservation

CO2-Understand the principles of chilling and freezing technology

CO3-Understand the mechanism of refrigeration and working of coolers/freezers

CO4-Understand the day today and unit operations of seafood freezing industry

CO5-Apply the principles in preserving fresh and processed foods for domestic/export markets.

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2
CO2	3	3	2	2
CO3	2	2	2	1
CO4	3	3	3	2
CO5	3	3	3	1

Module I : Spoilage in fish

Physical, chemical, microbiological, Need to prevent fish spoilage, methods to retard or prevent spoilage. Chilled storage of fish. Types of chilling, Heat load calculation, different types of ice, manufacture of ice, physical, chemical, microbiological and sensory changes during chill storage, melanosis and its prevention, iced storage shelf life, cold shock.

Module 2: Onboard handling of fish

Onboard chilling methods, handling of fish in landing centres, harbours etc. Transportation-live fish/shell fish, transportation of raw fish to local markets and processing centres, improvements needed in transportation, refrigerated transport systems, classification of transport vehicles, cold chain.

Module 3: Freezing of fish and shellfish

Refrigerants, classification of refrigerants, refrigeration cycle. structure of water and ice, influence of solutes on the structure of water and ice, phase equilibria and freezing curves of pure water and binary solutions, freezing curves for fish, determination of freezing points from time, temperature plots, calculation of freezing time; crystallization, nucleation-

homogeneous and heterogeneous nucleation; super cooling, crystal growth, eutectic point, location of ice crystals in tissue, changes during freezing.

Module 4: Technological aspects of freezing

Methods of freezing (plate freezing, IQF, etc), selection of a freezing method, product processing and packaging, packing of fresh and frozen fish for consumers, modified atmosphere packaging, controlled packaging.

Module 5: Frozen storage

Physical changes, freezer burn and recrystallisation, different types of recrystallisation. Chemical changes in lipids, proteins and nucleotides, freeze denaturation and theories on denaturation, changes in pH, bacterial changes, sensory changes, texture, taste, odour, effect of post-mortem condition on sensory qualities. Prevention of quality loss during frozen storage, treatments prior to freezing, antioxidants, cryoprotectants and other additives, theories of cryoprotection, glazing- importance and methods. Cold storage management- arrangements within a cold storage, handling and stacking systems. Time temperature tolerance, temperature and duration of storage on quality and shelf life.

Suggested Readings

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- Joan K. Loken (1995), The HACCP Food Safety Manual, John Wiley and Sons.
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- Da-wen Sun (2012), Handbook of frozen food processing and packaging, contemporary food engineering series, Taylor & Francis group.London.
- Herbert Stone & Joel L. Sidel (1985) Sensory evaluation practices- Food Science & Technology: A series of Monographs, Florida.
- Venugopal V.(2006) Sea food processing-Adding value through quick freezing, retortable packaging and Cook-chilling. CRC-Taylor & Francis group.

24-308-0204 THERMAL, NON-THERMAL PROCESSING AND PACKAGING TECHNOLOGY (3 Core)

Course Outcome (CO) : After completing the course, students will be able to

- CO1. Understand the principles and importance of seafood processing, including the role of processing in food safety and preservation.*
- CO2. Apply appropriate thermal processing techniques for seafood, considering factors such as heat transfer, equipment, and safety.*
- CO3. Evaluate and apply nonthermal processing techniques for seafood, including high-pressure processing, pulsed electric fields, and irradiation.*
- CO4. Explain the fundamentals of seafood packaging, including different packaging materials and their properties.*
- CO5. Apply advanced seafood packaging technologies, such as modified atmosphere packaging and vacuum packaging, to extend the shelf life and maintain the quality of seafood products.*
- CO6. Analyze and propose solutions for packaging challenges in the seafood industry, considering sustainability, safety, and consumer preferences.*

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	3
CO2	1	3	3	2
CO3	3	2	1	3
CO4	3	3	3	1
CO5	3	3	2	3
CO6	3	2	1	3

Module 1: Introduction to Seafood Processing

Overview of the seafood processing industry, Importance of seafood processing for food safety and quality, Introduction to thermal and nonthermal processing technologies

Module 2: Thermal Processing of Seafood

History and evolution of canning process, Principles of thermal processing, Mechanism of heat transfer, heat resistance of bacteria and spores, decimal reduction time, thermal death time, "Z" and "F" values, heat penetration, cold point, can size, shape, contents etc. definition of canning, absolute sterility, commercial sterility, pasteurization Vs sterilization. Canning process, steps involved, process flow, additives , HTST processing and aseptic canning , Canning machinery and equipment , Canning process of fish/shellfish , Value added canned products , Spoilage of canned food. Examination of cans and seams. Canning plant location: Practical considerations, canning plant facilities, lay out design. Retort Pouch Processing. Process machineries. Shelf life evaluation. Lamination process.

Module 3: Nonthermal Processing of Seafood

Introduction to Nonthermal Processing, Importance of nonthermal processing for preserving seafood quality and safety, Comparison of nonthermal and thermal processing methods, Principles and applications of High-Pressure Processing (HPP), Pulsed Electric Fields (PEF), Irradiation, Other Nonthermal Processing Techniques: Ultrasound, Ozone treatment, Pulsed light, etc.

Module 4: Freeze Drying Techniques for Seafood Preservation

Freeze drying: principles, application of phase rule, triple point of water, sublimation of ice, accelerated freeze drying (AFD), shelf life and specialties of AFD products, machinery and equipment for freeze drying, process flowchart. Packaging of Freeze dried products.

Module 5: Advanced Seafood Packaging Technologies

Retort pouch packaging, Vacuum Packaging, Polymeric Packaging Materials and their safe use in food contact application. Packaging requirements of fresh fish, frozen fish, Canned Fish, Dehydrated Fish and nonthermal processed products, etc. Insulated boxes. Accelerated shelf testing. Emerging trends in biodegradable plastic materials for seafood packaging. Biodegradable films, Bio plastics, materials advantages and disadvantages. Intelligent Packaging, Edible coating and innovations for enhanced shelf life of seafood.

Suggested Readings:

- Balasubramanian, S., & Marshall, D. L. (2014). Nonthermal processing technologies for food. John Wiley & Sons.
- Bhat, R., & Alias, A. K. (2018). Nonthermal Processing Technologies for Food. John Wiley & Sons.
- Chevalier, D., Le Bail, A., Ghidossi, R., & Oulahal, N. (2017). Non-thermal technologies for seafood processing: The perspective of emerging technologies. In *Innovations in traditional foods* (pp. 169-191). Springer, Cham.
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24-308-0205 PRODUCTION AND OPERATIONS MANAGEMENT IN FISHERIES INDUSTRY (4 Core)

Course Outcome (CO) : After completing the course, students will be able to

CO1- Understand the general concepts of production and operations management

CO2- Apply production management in seafood production systems

CO3- Apply production management in aquaculture systems

CO4- Analyse the production and operations systems in different fisheries organisations.

CO5- Evaluate the different production systems for enhancing quality production

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	3
CO2	3	2	3	3
CO3	3	2	3	2
CO4	3	2	3	2
CO5	2	2	2	1

Module 1. Introduction to Production and Operations Management -Production / operation management function- Production / operation system concepts, transformation process, Classification of Production system-Interaction of production/operation system with external environment - Case study- Seafood and aquaculture production systems

Module 2. Facility Location and Layout- Location objective- Selection of site- Location factors-Location industries- Location decision by firm- Types of layout- Process layout-Product lay-out fixed position layout- Assembly line

Module 3.Production and operations Planning–Forecasting- Aggregate Planning Capacity planning- Scheduling, Project Planning and control with Gantt Chart, PERT, CPM , Process Planning- Productivity-Job design- Man Machine system- Work study- Work measurement (Time study), Method Study (Motion Study), Work sampling

Module 4. Inventory Control and Materials Management- Need for inventory- Type of inventory- Scope and importance of inventory control- ABC and VED classification- Economic Order Quantity (EOQ)- Safety stock- Stores management- Integrated approach to materials management- Evaluation of materials management function- Classification of inventory items and systems of codification- Standardisation and simplification- JIT, Quality control- Basic concept of TQM-Standards-Statistical

Process Control(SPC), Acceptance sampling- Sampling plans- Control charts, Quality circles, - OC curve, Six sigma quality control-ISO Certifications

Module 5. Maintenance Management: Maintenance a function-Maintenance Management – Maintenance Decisions, Total Productive Maintenance (TPM), Reliability of equipments- Imploring equipment design- Preventive maintenance- Implementation of maintenance programmes

Suggested Reading

Aswathappa, K and Sridhara Bhat 2014. Production and Operations Management. Himalaya Publishing House, NewDelhi

Buffa, E S, Sarin, R. K. 2009. Modern Production/ Operations Management, 8th Edition. John Wiley and Sons (Asia) Pvt. Ltd.

Chary, S. N. 2012. Production and Operations Management, Fifth Edition Published by Tata McGraw-Hill Education Pvt. Ltd.

Venkateswarlu, K. 2013. Training on agricultural research management and project management techniques networks (Pert and CPM) in the United States of America, National Academy of Agricultural Research Management, 69 p.

24-308-0206 ECONOMICS OF FISHERIES PRODUCTION AND MARKETING (3 Core)

Course Outcome (CO) : After completing the course, students will be able to

- CO1. Appraise the role of fisheries in Indian economy and their importance in fish production and marketing.
- CO2. Gain theoretical understanding of production and marketing of fisheries.
- CO3. Apply Production functions in capture and culture fisheries.
- CO4. Compute cost and earnings of fishing vessels, fish farms and processing units.
- CO5. Understand the recent trends in supply of fish, major source and patterns of demand for fish in India.
- CO6. Evaluate the pricing procedure of marketing of fish in India.

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2
CO2	3	2	2	3
CO3	3	2	2	2
CO4	3	3	2	2
CO5	2	3	3	3
CO6	2	3	2	2

Module 1. Introduction - Fisheries Economics A new discipline, definition and scope of fisheries economics, environmental economics and sustainable development- Economic importance of fisheries – Contribution of fisheries to the national economy; empirical estimates. General classification of the fishing industry –Main industry and ancillary industries. Dynamics of development in the fishing industry, Technological change in the catching, culture, processing and marketing.

Module 2. Production theory of the Catching Sector, Culture Fishery and Processing Sector. The simple bio-economic model of production, institutional and economic models, production function of the commercial fishery, estimates of production function in the mechanized and non-mechanized sectors. Aquaculture system, systems based on farm size, technology and product mix-input-output tables of fish farms; estimates of production-function with variable inputs and proportions, economic and diseconomies of scale; optimum scale of production, value addition in the fisheries sector, input-output models of processing plants, estimates of production function in the freezing, canning, curing and other processing segments.

Module 3. Costs and Earnings of Fisheries Costs and Earnings of fishing vessels, Costs and earning of mechanized and non-mechanized units; estimates of break-even points and

comparative profitability. Costs and earnings of fish farms – Costs and earnings of major culture systems – economies of finfish and shellfish, mono-culture and poly-culture, inland and brackish, intensive and extensive farms; review of case studies .Costs and Earnings of Processing Units – Costs and earnings of freezing, canning, curing and value adding units, estimates of break-even points and comparative profitability: review of case studies

Module 4 Marketing of Fish in India (Supply and Demand) Supply ,demand and price dynamics in the fisheries sector, recent trends in demand for and supply of fish in India. Aggregate marine and inland, spatial, temporal and seasonal variation in supply of fish in India, trend in the supply of individual varieties and major economic groups of fishes in India, major forms in which fish is supplied in India, their absolute and relative shares. Major sources and patterns of sectoral and regional demand, demand for fish in India, estimates of current and future demand.

Module 5. Marketing of fish in India (Pricing Procedure) Market trends and diversification: Emerging consumer preferences and trade practices, Domestic and export marketing of fish and fish products, trends, channels, mechanisms, modern marketing methods and channels, cold chains, storage, value addition, Free market pricing in the primary market and secondary markets; direct sales, auction sales and contract sales, administered prices in the primary market, minimum price system and fixed price system. Recent trend in fish prices, wholesale and retail prices, price spread, price forecasting.

Suggested Reading

- Anderson Lee, G. 1977.Economics of fisheries management, John Hopkins University Press, Baltimore.
- Bell, F.W. 1998. Food from the sea, The Economics, Politics of Ocean Fisheries, West view Press, Boulder, Colorado.
- FAO, 1961.Report of the Technical meeting on Costs and Earnings of Fishing Enterprises, FAO, Rome.
- Ibrahim, P. 1992. Fisheries Development in India, Classical publications, New Delhi.
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- Huang, J, & Bouis, H. 1995. Structural changes in demand for food in Asia. [IFPRI] *Food, Agriculture, and the Environment Discussion Paper*, No. 11.
- IIFT, 1976. Indian institute of foreign trade. Survey of India's export potential of marine products, Govt. of India, New Delhi.
- Ministry of Agriculture 2014, Handbook of fisheries, statistics, Govt of India.
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- Ibrahim, P. Fisheries Development in India. Supplementary Reading Lawson, R.M. Economics of Fisheries Development.
- Panayatou, T. Smallscale Fisheries in Asia.. Socio-economic Analysis and Policy
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ELECTIVES

1. GLOBAL AQUACULTURE PRACTICES (2 credit)

Course Outcome (CO) : After completing the course, students will be able to

CO1- Understand the status of world aquaculture

CO2- Understand the role of aquaculture in world economy and employment

CO3- Understand major countries involved in world aquaculture practices.

CO4- Evaluate the contribution of major species of finfishes and shellfishes in aquaculture

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2
CO2	3	3	3	3
CO3	3	2	3	2
CO4	3	3	3	2

Module 1. Present status of global aquaculture production

Past and present trends in global aquaculture production and consumption; Issues, development and constraints in world aquaculture; Major countries (China, India, Indonesia, Vietnam, Bangladesh, Ecuador etc.) involved in aquaculture and their contribution in world aquaculture production. Status of world seaweed production; Role of aquaculture in world economy; Employment in aquaculture sector

Module 2. Innovative farming systems

Integrated Multi Trophic Aquaculture (IMTA); Recirculatory Aquaculture System (RAS); Bio-floc based aquaculture system; Periphyton based aquaculture; Bioremediation; Bioturbation technique; Aquaponics; Organic aquaculture; cage and enclosure systems in aquaculture; Flow-through raceways; Partitioned Aquaculture Systems; Application of artificial intelligence and robotics in aquaculture; Best aquaculture practices (BAP)

Module 3. Major finfish species in world Aquaculture

Grass carp, *Ctenopharyngodon idella*; Silver carp, *Hypophthalmichthys molitrix*; Nile tilapia, *Oreochromis niloticus*; Common carp, *Cyprinus carpio*; Bighead carp, *Hypophthalmichthys nobilis*; Carassius spp.; Catla, *Catla catla*; Atlantic salmon, *Salmo salar*; Striped catfish, *Pangasianodon hypophthalmus*; Roholabeo, *Labeo rohita*; Milkfish, *Chanos chanos*

Module 4. Major crustacean aquaculture

Whiteleg shrimp, *Penaeus vannamei*; Red swamp crawfish, *Procambarus clarkia*; Chinese mitten crab, *Eriocheir sinensis*; Giant tiger prawn, *Penaeus monodon*;

Module 5 Culture of molluscs and other animals

Cupped oysters nei, *Crassostrea* spp.; Japanese carpet shell, *Ruditapes philippinarum*; Scallops nei, *Pectinidae*;, *Trionyx sinensis*; Japanese sea cucumber, *Apostichopus japonicus*. Culture of seaweeds

Suggested reading

- Bardach, J. E. 1997. Sustainable Aquaculture. John Willey & Sons. 251p
- De Silva, S.S and. Anderson T.A 1995. Fish Nutrition in Aquaculture. Chapman & Hall Aquaculture Series. 320p
- Diwan, A.D., Joseph, S and Ayyappan S. 2008. Physiology of Reproduction, Breeding and Culture of Tiger Shrimp. Narendra Publ. House. 292p.
- Elena M. 2003. Nutrition, Physiology and Metabolism in Crustaceans. Science Publishers. 160p.
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- Hertrampf, J.W and Pascual F.P. 2000. Handbook on Ingredients for Aquaculture Feeds. Kluwer. 573p
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- Leung, P., Lee, C.S. and O'Bryen J.P. (Eds.). 2007. Species and System Selection for Sustainable Aquaculture. Blackwell Publ. 528p
- Midlen and Redding T.A. 1998. Environmental Management for Aquaculture. Chapman & Hall. 224p
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- Pillay, T.V.R and Kutty M.N. 2005. Aquaculture: Principles and Practices. 2nd Ed. Blackwell. P- 640p
- Pillay, T.V.R. and Kutty M.N. 2005. Aquaculture- Principles and Practices. Blackwell. 624p
- Rajagopalsamy, C.B.T. and Ramadhas, V. 2002. Nutrient Dynamics in Freshwater Fish Culture System. Daya Publ. 140p
- Rath, R.K. 2000. Freshwater Aquaculture. Scientific Publ. 597p
- Reddy, P.V.G.K. 2005. Genetic Resources of Indian Major Carps. FAO Publ.
- Santhanam, R. 1990. Coastal aquaculture in India. CBS Publications. 174p
- Selvamani, B.R and Mahadevan, R. 2008. Aquaculture, Trends and Issues. Campus Books International. 284p.
- Sharma, L.L., Sharma, S.K., Saini, V.P. and Sharma B.K. 2008. Management of Freshwater Ecosystems. Agrotech Publ. Academy.
- Avnimelech, Y (2015) Biofloc technology- a practical guide. World Aquaculture Society. 258p
- Harvey, B., Soto, D., Carolsfeld, J. and D.M. Bartley (2017) Planning for aquaculture diversification. The importance of climate change and other drivers. FAO Rome, 156p
- Samocha, T.M. (2019) Sustainable biofloc systems for marine shrimp. Academic Press, Elseiver. 432p

2. ANALYTICAL METHODS FOR SEAFOOD QUALITY

ASSURANCE (2 credit)

Course Outcome (CO) : After completing the course, students will be able to

CO1- Understand the mechanism and factors influencing the fish spoilage

CO2- Demonstrate the factors responsible for the physical, chemical and microbiological quality of seafood

CO3- Apply sensory methods for fish quality assessment

CO4- Apply the biochemical methods for fish quality during fresh, chilled, frozen conditions.

CO5- Apply various instrumental techniques for seafood quality evaluation at laboratories and in seafood processing units.

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2
CO2	3	3	2	2
CO3	3	3	2	2
CO4	3	3	2	2
CO5	3	3	2	2

Module 1: Seafood spoilage

Changes in flavor, texture, protein, lipid etc. Melanosis and its prevention, Discoloration in aquatic products. Auto-oxidation- mechanism, role of antioxidants, synergistic and pro-oxidants, factors responsible for lipid oxidation in fish muscle. Storage methods and factors influencing the storage of fresh, chilled, frozen and canned products.

Module 2: Sensory evaluation

sensory characteristics, Sensory evaluation of fresh fish and fish products- basic aspects, different methods of evaluation, taste panel selection and constitution, statistical analysis. Sensory changes- texture, taste, odour, effect of post-mortem condition on sensory qualities, water holding capacity, time temperature tolerance, temperature and duration of storage on quality and shelf-life. Quality Index Method (QIM).

Module 3: Chemical analysis of seafood

Determination of pH in fish muscle, factors influencing the changes in pH. Drip loss, calculation of drip loss. Quality analysis of pasteurized and canned products. Biochemical analysis of seafood: Lipid-protein interaction and their impact on quality. Methods of

addressing lipid oxidation in fish and fishery products, methods of assessing oxidative and hydrolytic rancidity. Changes of nitrogen, volatile compounds, Ammonia, Trimethyl amino oxide, amino acids, peptides etc.

Module 4: Instrumental techniques for seafood quality evaluation

Texture of fish muscle, significance of texture in seafood quality, texture profile analysis, factors influencing the texture of muscle foods., freshness tester, Torry meter, fat detector for seafood quality testing, advanced instruments for flavor testing, mechanism of flavor changes in seafood. Significance of colour of seafood, colour measurement. Rheology: Flow behavior of fluid system, Newtonian fluids, non-Newtonian fluids, deformation behaviour of solid food material, elastic behaviour, plastic behaviour, visco-elastic behaviour, strength of food material, applications. Measurement of properties of surimi Products, IQF products, AFD products, fish balls and paste.

Module 5: Microbiological analysis

Factors influencing the microbial quality of seafood. Essential requirements for a microbiological laboratory. Quality characteristics of water, ice and fish. Sterilization, sample preparation for microbiological quality analysis, Spoilage bacteria and pathogenic bacteria. Methods of enumeration of bacteria. Media, colony characteristics, confirmatory tests. Limits of microorganisms in seafood for export. Molecular confirmation of bacterial strains. Advanced technologies for rapid detection of micro organisms in seafood for export. Microbiological quality evaluation of dried foods.

Suggested Reading

- Wheaton F.W and Lawson T.B (1985) Processing of Aquatic Food Products, John Wiley & Sons, New York.
- Huss H.H (1994), Assurance of Seafood Quality, FAO Fisheries Technical paper – 334, FAO.
- Joan K. Loken (1995), The HACCP Food Safety Manual, John Wiley and Sons.
- Connel J.J (1980), Control of Fish quality. Fishing News Books Ltd., England.
- Quality Assurance in Seafood Processing, (2000) Society of Fisheries Technologists, (India) Cochin.
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- Davies. R (1982) Developments in Food Microbiology, Applied Set. London.
- Alasavar .C Taylor. T. (2002), Seafood -quality, Technology and Nutraceutical applications, Springer-Verlag Berlin.
- Herson.A.C. &Hulland. E. D. (1964) Canned Foods, An Introduction to their Microbiology.
- Da-wen Sun (2012), Handbook of frozen food processing and packaging, contemporary food engineering series, Taylor & Francis group.London.
- Herbert Stone & Joel L. Sidel (1985) Sensory evaluation practices- Food Science & Technology: A series of Monographs, Florida.

Venugopal V.(2006) Sea food processing-Adding value through quick freezing, retortable packaging and Cook-chilling. CRC-Taylor & Francis group.

3. OCEANIC AND DEEP SEA FISHERIES (2 credit)

Course Outcome (CO) : After completing the course, students will be able to

CO1- Understand the potential resources in deep sea

CO2- Explain outcomes of exploratory surveys conducted in deep sea

CO3- Delineate areas of potential deep sea fishery

CO4- Apply historic data on abundance of deep sea resources

CO5- Predict future strategies in improving fishery production from deep sea

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3
CO2	2	2	1	2
CO3	3	2	1	-
CO4	2	2	2	-
CO5	3	3	3	2

Module 1. World tuna resources

Present status – important fishing areas and level of exploitation; handling peculiarities. Important species contributing to fishery and their bionomics. Migratory patterns and environmental factors affecting migration.

Module 2. Tuna fishery of Indian ocean

Present trend in species wise production. Countries involved in the Indian ocean tuna fishery and their contribution. Tuna resources of the EEZ of India. Results of exploratory and synoptic surveys conducted by the Government of India, feasibility methods. Perspectives and management of Indian tuna fisheries.

Module 3. International arrangement for tuna management

Major problem areas, open access with participation fees. Indian Ocean Tuna Commission (IOTC), World Tuna conservation measures.

Module 4. Fishery of seer fishes, billfishes, sword fishes, cephalopods and marine mammals of the Indian ocean, with emphasis on available resources of the EEZ of India. Important fishing areas.

Module 5. Deep sea / Mesopelagic fish resources in India

Area-wise, depth-wise and season wise distribution. Abundance of bull-eye, black ruffs, drift fishes, carangids, threadfin breams, rock cods, other Serranids and perches. Approaches to the development of deep sea fishery – general outlines and strategy. National policies-chattering of foreign vessels and joint ventures. Agencies involved in deep sea fishery ventures in India.

Suggested readings

- Anon, 1994. Pelagic Fisheries of the Western Pacific Region, Amendment 7 to the Fisheries Management Plan (FMP): Environmental Impact Statement.
- Anon, 1999. Pelagic Fisheries of the Western Pacific Region: Annual Report. Western Pacific Regional Fishery Management Council (USA).
- Daniel, P. and Jay, M. 2003. In a Perfect Ocean: The State Of Fisheries and Ecosystems In The North Atlantic Ocean. Island Press- Nature. p.175.
- Dennis, R., Sanjay C., and Vijay, S. 2009. Fisheries Exploitation in the Indian Ocean: Threats and Opportunities. Institute of Southeast Asian Studies.
- Food and Agriculture Organization of the United Nations. Deep Sea Cartilaginous Fishes of the Indian Ocean. FAO Species Catalogue for Fisheries Purposes. p.264
- Merrett, N. R. and Haedrich, R. L. 1997. Deep-Sea Demersal Fish and Fisheries (Fish & Fisheries Series). Springer; 1997 edition. p.282
- Mogalekar, H. S. and Jawahar, T. 2015. Status and Management of Small Pelagic Fisheries of India. Omniscryptum Gmbh & Company Kg., p.56

4. FISH PROCESSING TECHNOLOGY (Practical) (1 credit)

Course Outcome (CO) : After completing the course, students will be able to

After completing the course, students will be able to

- CO1. Demonstrate proficiency in conducting sensory evaluation of raw and frozen fin fish and Shellfishes.*
- CO2. Apply preprocessing techniques such as filleting and processing of prawns, squid, and cuttlefish, including yield calculations.*
- CO3. Conduct chill storage studies, including chemical, physical, and sensory analyses, to determine shelf life of seafood products.*
- CO4. Evaluate frozen/chilled fish using biochemical, microbiological, and sensory methods.*
- CO5. Demonstrate competence in canning techniques, including operation of overpressure autoclaves and examination of canned fishery products.*

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2
CO2	1	3	2	1
CO3	3	3	2	2
CO4	3	3	2	3
CO5	1	3	3	3

Module 1. Sensory Evaluation Techniques:

- Demonstrate proficiency in conducting sensory evaluation of raw and frozen fin fish and shellfishes.
- Interpret sensory analysis results to assess the quality of seafood products.

Module 2. Seafood Preprocessing:

- Perform filleting techniques for fish and processing methods for prawns, squid, and cuttlefish, while accurately calculating yield.
- Evaluate the quality of processed seafood products.

Module 3. Chill Storage Studies:

- Conduct chemical, physical, and sensory analyses of chilled seafood, and determine the shelf life of chilled seafood products.
- Make informed decisions regarding the storage and quality maintenance of chilled seafood.

Module 4. Evaluation of Frozen/Chilled Fish:

- Use biochemical, microbiological, and sensory methods to evaluate frozen and chilled fish, ensuring compliance with quality and safety standards.
- Implement corrective measures to maintain the quality of frozen and chilled seafood.

Module 5: Evaluation of Canned Products

Conduct thorough examinations of canned fishery products to assess quality and safety.

Identify and address potential issues related to can seams and sterility of canned products. Monitor and control double seam parameters, heat penetration curve, Fo Value, Z value, and process time for optimal canning outcomes.

Suggested Readings:

- Balachandran, K.K. 2003. Fish Canning Principles and Practices. CIFT, Cochin.
 Gopakumar K. 2002. Text Book of Fish Processing Technology. ICAR, New Delhi .
 Hall G. M. 1992. Fish Processing Technology 1992. Blackie Academic and
 Larousse, J and Brown, B. E. 1997. Food Canning Technology. Willey VCH New York.
 Regenssein, J. M. and Regenssein, C. E., 1991. Introduction to fish technology.
 Sen D. P. 2005. Advances in Fish Processing Technology. Allied Publishers Pvt. Ltd.

5. FISHING GEAR TECHNOLOGY (Practical) (1 credit)

Course Outcome (CO) : After completing the course, students will be able to

- CO1. Understand and demonstrate design principles of fishing gears*
CO2. Create design drawing of fishing gears
CO3. Analyze various stages of fishing gear manufacturing on an industrial level.
CO4. Compare different types of facilities available in net making yards and fishing harbors.
CO5. Apply advanced knowledge in fishing gear fabrication for design development of sustainable fish harvesting systems.

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	2
CO2	1	2	3	1
CO3	3	2	2	3
CO4	3	2	1	3

Module 1

Shaping of Netting, Baiting, Creasing, Tailoring, Fly meshing, Mounting, Different methods of mounting; Mending of nets

Module 2

Fishing Gear design reading and drawing Preparation of design drawing and specifications of traditional and mechanized fishing gears.

Module 3

FIELD VISIT - Net making factory and Net repair yards

Module 4

FIELD STUDY - The student has to visit boat building yards, fishing harbours, docking yards.

Module 5

FIELD REPORT- Submit comprehensive reports on activities connected with fishing craft/gear construction.

Suggested Reading

- Andreev, N. N. (1966) Construction and Designing of Purse Seines. FAO/USSR study tour on instrumentation in fishing technology. 39p.
- Anon 1979 Performance and efficiency of otter board designs, *World Fishing*, 28 (7): 57-59.
- Baranov, F.I. (1976) Selected Works on Fishing Gear, Commercial Fishing Techniques, Vol.1, Israel Programme for scientific translations, Keter Publishing House Ltd., Jerusalem, 631p.
- Ben-Yami, M. (1994) Purse Seining Manual, Fishing News Books, Osney Mead, Oxford OX2 0EL, England: 406p.
- Bergstrom, M. (1983). Review of experiences with and present knowledge about fish aggregating devices, BOBP/WP/23 Bay of Bengal programme, Madras.
- Bjorndal, Å. and Lokkeborg, S. (1996) Longlining, Fishing News Books, ISBN 0852382006, 170p.
- Boopendranath, M.R., Sankar, T.V., Jeeva, J.C., and Kumar, R., Eds.), Society of Fisheries Technologists (India), Cochin-1-9: 79-103
- Brandt von, A., (1972) Fish Catching Methods of the World, Fishing News (Books) Ltd., Surrey, 240p.
- Brandt von, A., (1984) Fish Catching Methods of the World – 3rd edition, Fishing News Books, Osney, Mead, Oxford OX2 OEL, England, 418p.
- Chapelle, H.I. (1994) Boatbuilding: A Complete Handbook of Wooden Boat Construction, W.W. Norton, ISBN 0393035549, 624p.
- Coackley, N. (1991) Fishing Boat Construction: Building a Fiberglass Fishing Boat, Issue 321 of FAO fisheries technical paper, FAO, ISBN 9251031169, 84p.
- FAO (1974) Otter board Design and Performance, FAO Fishing Manuals, FAO of UN, 79 p.
- FAO (1975) FAO catalogue of small-scale fishing gear, Fishing News (Books) Ltd., Surrey, England, 191p.
- FAO (1995) Code of conduct for responsible fisheries, FAO, Rome, 41p.
- FAO (2003) Fisheries management. 2. The ecosystem approach to fisheries, FAO Technical Guidelines for Responsible Fisheries – No.4, Suppl.2, FAO Rome.
- Fridman, A.L. (1986) Calculations for Fishing Gear Designs, FAO Fishing Manual, Fishing News Books, Oxford: 241p.
- Klust, G. 1964 Netting twines of polypropylene and polyamide compared. In *Modern Fishing Gear of the World 2.*, Fishing News (Books), Ltd., Surrey, England: 54p.
- Leela Edwin, Saly N Thomas, M. P Ramesan , P Mohammed Ashraf, M V Baiju, Manju Lakshmi N, and Madhu R (2019) Responsible Fishing: Recent advances in resource and energy conservation, Publ by Dr.Ravisankar C N, Director, ICAR Central Institute of Fisheries Technology, November 2019, 432p.
- Prado (1990) Fisherman's Workbook. Fishery Industries Division, Published by arrangement with the Food and Agriculture Organization, of The United Nations, Fishing News Books Oxford 1990. ISBN 0-85238-163-8
- Sainsbury, J. C. (1996) Commercial Fishing Methods- An Introduction to Vessels and Gears. Third Edition, Fishing News Books, Osney Mead, Oxford OX2 OEL, England: 359 p.
- ShahulHameed, M. and Boopendranath, M. R. (2000). Modern fishing Gears of the world, Diya publication house, New Delhi.
- Shibu.A.V. (2017) Fishing Gear Materials Accessories and Design- Revised Second Edition (Publisher- Director, CIFNET, Govt. of India, Kochi -16, ISBN Number - 81-87245-16-6)

6. CASE STUDY ON ECONOMICS OF FISHERIES PRODUCTION AND MARKETING (1 credit)

Course Outcome (CO) : After completing the course, students will be able to

- CO1. *Appraise the role of fisheries in the Indian economy and their importance in fish production and marketing.*
- CO2. *Gain theoretical understanding of production and marketing of fisheries.*
- CO3. *Apply Production functions in capture and culture fisheries.*
- CO4. *Compute cost and earnings of fishing vessels, fish farms and processing units.*
- CO5. *Understand the recent trends in supply of fish, major sources and patterns of demand for fish in India.*
- CO6. *Evaluate the pricing procedure of marketing of fish in India.*

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2
CO2	3	2	2	3
CO3	3	2	2	2
CO4	3	3	2	2
CO5	2	3	3	3
CO6	2	3	2	2

Case study Analysis report regarding the role of fisheries in the Indian economy and their importance in fish production and marketing. Application of theoretical understanding of production and marketing of fisheries. Case study of cost and earnings of fishing vessels, fish farms and processing units, the recent trends in supply of fish, major source and patterns of demand of fish in India and Evaluate the pricing procedure of marketing of fish in India.

Visit to fishing harbours, marketing centers, aquaculture farms, fishing community villages, seafood industry, seafood processing units, fisheries institutions for conducting socio economic studies, cost and earnings and economic viability analysis of fisheries production and marketing.. Study on demand for and supply of fisheries related products. Submission of case study report.

7. INTERNSHIP IN SEAFOOD INDUSTRY (4 credit)

Course Outcome (CO) : After completing the course, students will be able to

CO1. Apply principles of seafood supply chain management in real-world settings.

CO2. Evaluate and ensure seafood quality using sensory, microbiological, and biochemical analysis techniques.

CO3. Develop and implement Good Manufacturing Practices (GMP) and Hazard Analysis and Critical Control Points (HACCP) principles in seafood processing.

CO4. Demonstrate knowledge of waste management and effluent treatment methods specific to seafood processing units.

CO5. Acquire technical skills in seafood processing and marketing relevant to the industry.

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	3
CO2	3	3	3	2
CO3	3	3	3	2
CO4	2	3	3	3
CO5	3	3	2	3

Students are expected to have hands-on-experience on various aspects of supply chain in the production and marketing of seafood.

Students should undergo training in quality assurance and management including training in organoleptic quality, microbiology and bio-chemical analysis with respect to national and international standards.

Students should have thorough understanding on the GMP / HACCP and other quality management systems including preparation of HACCP manual and Export Documentation procedures.

Students should also learn waste management/ treatment practices and various systems of effluent treatment methods used in seafood processing units.

THIRD SEMESTER

24-308-0301 HATCHERY TECHNOLOGY OF CULTIVABLE FINFISHES AND SHELL FISHES (3 Core)

Course Outcome (CO) : After completing the course, students will be able to

CO1- learn and provide overall knowledge about seed production and hatchery management of commercially important cultivable fishes, crustaceans and molluscs

CO2- achieve competency and expertise to manage commercial fin and shell fish hatcheries

CO3- cater manpower requirement in hatchery operation of fishes, crustaceans and mollusks for promotion of aquaculture production and export

CO4- make available seeds of fin and shell fishes in sufficient numbers as the requirement of farmers

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2
CO2	2	3	3	2
CO3	1	1	3	3
CO4	2	2	1	2

Module 1: Introduction

History, current status and constraints of seed of aquaculture important species; Natural seed resources, collection methods, handling, packing and transportation; merits and demerits of natural seeds.

Module 2: Reproductive biology of finfishes

Environmental and endocrine control of reproduction: reproductive cycles, seasonality (photoperiod, change in water quality and quantity, temperature, lunar cycle, etc.). Induced spawning: methods of natural and artificial fertilization, GnRH and Linpe models, egg staging, stripping and fertilization, evaluation of milt and egg, cryopreservation technique, use of different synthetic hormones and analogues for induced spawning. Induced spawning in invertebrates.

Module 3: Design considerations of marine hatchery, freshwater hatchery, shrimp hatchery Criteria for site selection of hatchery and nursery; culture and use of different live feed in fin and shellfish hatcheries; Diseases and their management in hatcheries; different chemicals and drugs used; water quality and feed management; Hatchery standards and

biosecurity; Sanitary and Phytosanitary (SPS) measures; Better Management Practices (BMPs); packaging and transport of seeds.

Module 4: Hatchery technology for different cultivable fin fish species

Seed production and hatchery management of important aquaculture fin fishes- Indian major and minor carps, exotic carps, catfishes, tilapia, masheer, trout, seabass, milkfish, mullets, sea breams, pompano, silver pomfret, grouper, *Lutjanus argentimaculatus*, yellowtail, eel and cobia.

Module 5: Hatchery technology for different cultivable invertebrate species

Seed production and hatchery management of commercially important prawns, shrimps, crabs, lobsters, mussels, edible oysters, pearl oyster, scallops, clams and sea cucumber.

Suggested reading

- Chakraborty, C and Sadhu A. K. 2000. Biology Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn. Daya Publ. House. 102p
- Chattopadhyay (2017) Induced fish breeding. A practical guide for hatcheries. Academic Press 332p
- CMFRI Bulletin. 1987. National Seminar on Shellfish Resources and Farming.
- Cole, R.S. (2010) Reproduction and sexuality in marine fishes. Patterns and Processes. University of California Press, 409p
- FAO. 1992. Manual of Seed Production of Carps. FAO Publication
- FAO. 2007. Manual for Operating a Small Scale Recirculation Freshwater Prawn Hatchery
- Finn, R.N and Kapoor B.G. 2008. Fish Larval Physiology. Science Publ. 742p
- Guillame, J., Kaushik, S., Bergot, P. and Metallier, R. 2001. Nutrition and Feeding of Fish and Crustaceans. Springer Praxis Publ. 408p
- ICAR. 2006. Hand Book of Fisheries and Aquaculture. ICAR.
- 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 Publication.
- Landau M. 1992. Introduction to Aquaculture. John Wiley & Sons.
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- Pillay TVR & Kutty MN. 2005. Aquaculture- Principles and Practices. Blackwell.
- Rath RK. 2000. Freshwater Aquaculture. Scientific Publication.
- Roch, M.J., Aukwe, A. and B.G. Kapoor (2008) Fish reproduction. Science Publishers. 653p
- Thomas PC, Rath SC & Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publication.
- Thomas, P.C, Rath, S. C. and Mohapatra, K.D. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ. 402p
- Wootton, R.J. and C. Smith (2015) Reproductive biology of teleost fishes. John Wiley & Sons 451p

24-308-0302 VALUE ADDED PRODUCTS TECHNOLOGY (3 Core)

Course Outcome (CO) : After completing the course, students will be able to

- CO1. Understand the concept and significance of seafood value addition, including its role in increasing product diversity and market competitiveness.*
- CO2. Apply appropriate techniques for handling and preprocessing seafood to maintain quality and safety.*
- CO3. Analyse proficiency in the production of cured fish products, minced fish, surimi-based products, battered, and breaded seafood products.*
- CO4. Explain the principles and applications of extrusion technology in seafood processing.*
- CO5. Apply food safety and quality assurance principles throughout the seafood value addition process.*

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	3
CO2	3	3	2	3
CO3	3	3	2	2
CO4	1	2	1	2
CO5	3	2	3	3

Module 1: Introduction to Seafood Value Addition

Overview of seafood value addition: definition, importance, and scope, Market trends and consumer preferences in value-added seafood products, Principles of value addition: enhancing quality, extending shelf life, adding convenience, Factors influencing value addition in seafood, Current status and constraints of value addition in seafood, Future Trends in Value Addition, etc.

Module 2: Raw Material Handling and Preprocessing of seafood

Organoleptic Evaluation Criteria, Organoleptic Evaluation of Raw Materials, Raw Material Receiving Quality, Calculation of Shrimp Count, Demonstration of Grading, Live Fish Quality Check, Condition of Carriage, De-icing and Washing, Sorting of Raw Materials, Re-icing, etc., Cleaning and Washing Techniques, Cutting and Filleting, Equipment and Machinery Used in Preprocessing- Overview of commonly used equipment (e.g., knives, scales, filleting machines), Maintenance and cleaning of equipment for safe use, storage of pre-processed seafood, waste management, etc.

Module 3: Minced Fish and Surimi based products

Importance of mince in seafood processing, Methods for preparing mince from different seafood species, Equipment and machinery for mince preparation, Quality considerations in mince production, freezing, and frozen storage of fish mince. Value-Added Products from Mince- fish balls, fish cakes, fish sausages, etc.

Surimi: basic concepts, process elements, washing process, strainer, dehydrator, cryoprotectants, freezing, and storage of surimi, Gel formation, gel structure, types of gels, and evaluation methods, Surimi-based products: kamaboko type products, fish burger, cutlet, texturised products, moulded products, formulated products, etc.

Surimi Analogue products: basic concepts, process elements, ingredients, product design and production. Quality evaluation of surimi analogue products

Module 4: Battered and Breaded Seafood Products

Present and potential market, ingredient for batter system, flavorings and seasonings in batter and breading systems, batter and breading process, equipments, application of batters and breading to sea foods, trouble shooting, technique for batter and breading systems. Battered and breaded fish, shrimp, squid products. Quality evaluation of battered and breaded products.

Module 5: Extrusion Technology

Extrusion Technology: Importance, principles of extrusion cooking, methods of extrusion cooking. Extruders; Types of extruders, single screw, twin screw their applications, effect of dependent and independent variables on the product quality. Extruded products; Raw materials, process of manufacture, properties, quality, evaluation, packaging requirement, marketing. Factors affecting extrusion cooking-moisture content, temperature, pressure, screw speed, time etc- quality evaluation of these products.

Suggested Readings:

- Balachandran, K. K. 2001. Post-harvest technology of fish and fish products. Daya Publishing House, New Delhi.
- Bligh, E. G. 1992. Seafood science and technology, Fishing News Books. Borgstrom, G. 1961. Fish as food Vol. I- IV Academic Press, New York.
- Gopakumar, K. 2002. Text book of Fish Processing Technology. Indian Council of Agricultural Research, New Delhi.
- Govindan, T. K. 1985. Fish processing technology. Exford& IBH Publishing Co. Pvt. Ltd., New Delhi.
- Johnson, A. H. and Peterson M. S. 1974. Encyclopedia of Food Technology, Vol.1st and 2ndEdtn. Amerind Publishing Company, Pvt. Ltd, New Delhi.
- Proceedings on Summer Institute on Non-Traditional diversified fish products & by-products, CIFT, Cochin.
- Roller, T. and Christian. 1995. Water activity and food, Academic Press, London Seow, C.C. 1986. Food Preservation by moisture control, Elsevier Applied Science, New York.
- Tressler, D. K. and Lemon, J. W. 1960. Marine Products of Commerce.
- Wheaton, F.W. and Lawson, T. B. 1985. Processing of Aquatic Food Products. Wiley Publ. New York.

24-308-0303 ADVANCEMENTS IN FISHING TECHNOLOGY AND RESPONSIBLE FISHING APPROACHES (3 Core)

Course Outcome (CO) : After completing the course, students will be able to

CO 1: Describe various gear handling equipments on-board commercial fishing boats

CO 2: Evaluate the concept of energy optimization and green fishing for fuel efficiency of different fishing operations

CO 3: Apply CCRF approaches to be adopted in future R&D programmes and design development of resource specific fishing gears.

CO 4: Explain principles and methods operation of marine electronic equipment used on board the fishing boats for improving efficiency of fishing operations

CO 5: Apply GIS and remote sensing technologies to achieve energy efficiency in fishing operations

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	3
CO2	2	3	2	1
CO3	3	2	3	3
CO4	2	2	3	1
CO5	3	2	3	3

Module 1.Fishing operations

Methods of fishing operations- Traditional, Commercial, Exploratory, Experimental, Resource specific fishing operations.

Deck Layout & Deck Equipment - General arrangement and deck lay out of Trawler, Purse, seiner, Gillnetter, Long liner and Combination Vessel (Trawler-cum-longliner).

Module 2.Trawl fishing

Different types of trawling operations. Gill netting – Principle, Types of Gill net operations.

Surrounding nets – Operation of Purse seine – single boat purse- seining, double boat purse seining. Line fishing - Pole and line operation, Oceanic Long line operation (monofilament & multifilament), Trolling; Oceanic Squid jigging. Trap fishing methods.

Optimization of fishing systems, Green fishing.

Module 3.Responsible fishing practices

FAO code of conduct for responsible Fisheries- Article 8, Fishing operations, Technologies for Selective Fishing gear and practices, Environment friendly fishing gears and methods, Techniques reducing the risk of unsustainability, IUU fishing Energy conservation in harvesting –BRDs / TEDs / .Fish Aggregation Devices: Types of FAD, Technical aspects on Setting, Construction, Deployment and Maintenance of anchored and drifting FADs.

Module 4.Marine Electronic Equipment's

Principles, methods of operation, technical specifications and care of Navigational- (G.P.S, RADAR, NAVTEX, AIS) Communication (VHF, HF, MF, INMARSAT) Fish Finding

(ECHO SOUNDER, NET SOUNDER, SONAR) and Life Saving Equipments (SART, EPIRB.).

Fishing and Navigation Signals. Life-saving and Fire Fighting appliances on board fishing vessels. Global Maritime Distress and Safety System

Module 5.Applications of Remote Sensing (RS) and GIS to fisheries

Identification of Potential Fishing Zones (PFZ), Participatory GIS in fishing systems, Theme Maps, applications of RS and GIS in fisheries.

Sustainable fishing gears and devices, Designing of ecofriendly long line, Eco-friendly gillnet, Eco-friendly trawl net, , Eco-friendly fishing gears.

Suggested reading

Baranov, F.I. 1976. Selected Works on Fishing Gear, Commercial Fishing Techniques, Vol.1, Israel Programme for scientific translations, Keter Publishing House Ltd., Jerusalem. fishing, Society of Fisheries technology, CIFT- 8-9 August ,1991,Kochi

Joshy, C. D. and Devadhason, M. 2001. Basic Electronics and Fish Finding Equipments. CIFNET. Cochin: 42p.

Ravindran, K.1991. Low energy fishing-proceedings of National work shop on Low energy

Sainsbury, J. C. 1996 Commercial Fishing Methods-An Introduction to Vessels and Gears. Third Edition, Fishing News Books, Osney Mead, Oxford OX2 OEL, England.

Shahul Hameed, M. and Boopendranath, M. R. 2000. Modern fishing Gears of the world, Diya publication house, New Delhi.

Shibu.A.V. 2017 Fishing Gear Materials Accessories and Design- Revised Second Edition (Publisher- Director, CIFNET, Govt. of India, Kochi -16, ISBN Number - 81-87245-16-6)

Udayaprakasan, K.C. 2000. Rule of the road, Signal and buoyage — CIFNET publication.

Von Brandt, A. 1984. Fish catching methods of the world 3rd edition, FAO Fishing News Books, England.

Von Brandt,A.1972. Fish catching methods of the world, FAO Fishing News Books Ltd. Surrey.

24-308-0304 SUSTAINABLE FISHERIES MANAGEMENT (3 Core)

Course Outcome (CO) : After completing the course, students will be able to

CO1- Sketch the structure and dynamics of the fishery system and appraise the dichotomy between small scale and large scale fisheries.

CO2- Explain the nature and structure of the policy and planning process in fisheries Management.

CO3- Identify strategic objectives, major policy issues in sustainable fishery development and summarize in a policy flow chart.

CO4- Examines the need for fishery research, the nature of research, its institutional and disciplinary structure of research and the participants in research.

CO5- Recognize the need for resilience in fishery systems and for robustness in the management system.

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	1
CO2	3	3	3	2
CO3	3	3	2	2
CO4	3	2	2	3
CO5	3	2	2	2

Module 1. Fishery System: Structure and Dynamics Fishery Systems- The Natural System- Human System- Fishers, Typology of fishers, beyond fishers- Post harvest sector and consumers, Marketing and distribution, - Fishing households and communities- Socio economic environment, The Management System. Dynamics of fishery system

Module 2. The Management System: Policy and Planning Fisheries Policy And Planning - Fishery Objectives – A portfolio of fisheries objectives – Priorities and conflict - Fishery Management Institutions, Time scales and special scales of management. Fishery Management Measures, Technical and Technological Measures - Ecosystem Approaches to Management.

Module 3. Sustainability in Fisheries System and Fisheries Development.

Nature of Sustainability - Sustainability Assessment in Fisheries System -Components of Sustainability -Checklist and Indicators -Indices of sustainability and validation of Sustainability Indicators, Participatory Fishery Development and measures – Fishery Research. Fishery Certifications, Organic fishery products, MSC, ASC, Friend of Sea, MPEDA-SHAPHARI Certifications for Hatcheries & Farms.

Module 4. Uncertainty and Precautionary Approach. Sources of Uncertainty in Fisheries -Typology of Uncertainty – Impact of uncertainty – Risk- Challenges of Structural Uncertainty -Precautionary Approach, Complexity of Ecosystem Approach Approaches in Fisheries Management System.

Module 5. Resilient Fishery System and Management. Introduction -Resilience and Robust management -Application of Robust management- Conflicts and Co - Management Approach, Self regulatory institutions -Fishery System Planning – Livelihood diversification - Use of Traditional and Ecological knowledge, Rights in Fishery system.

Suggested reading

- Anderson, 1997. L.G. Economics of Fisheries Management, John Hopkins University Press, Baltimore.
- Anderson.L.G and Seijo, J. C.2010. Bioeconomics of Fisheries Management, Wiley- Blackwell.
- Berkes, F., Mahon.R., McConney, P. Pollnac, R and Pomeroy, R. 2001.[Managing Small-Scale Fisheries: Alternative Directions and Methods](#)
- Charles, A. 2001. Sustainable Fishery Systems. Blackwell Publication, 370 pp
- David Symes,1999. Property Rights and Regulatory System in Fisheries, Fishing News Books, London.
- FAO, 1992. Marine Fisheries and Law of the Sea - A Decade Change, FAO, Rome,
- FAO, 1995. Code of conduct for Responsible Fisheries. Rome, 41 pp.
- FAO, 1998. FAO Technical Paper 424 A Fishery Managers Guide book Management Measures and their Application (Edited By Cochrane.K.L).
- FAO, 2006, Technical Guidelines for Responsible Fisheries, No. 4.
- Francisco J. Marí (2018) SDG 14: Sustainable fishery or Blue Economy? Bread for the World – Protestant Development Service
- Goankar,R., Patil, R.B. and Rodrigues, M. 2006. Fishes and Fisheries Management – Conservation and Sustainable Development, APH Publishing Corporation, New Delhi.
- Korakandy, R. 1996. Economics of Fisheries Management – A Critique in Third World Perspective, Daya Publishing House, New Delhi,.
- Lawson, R.M. 1984. Economics of Fisheries Development, Frances Pinter (Publishers), London,
- Mc Clanahan. T.R and Castilla, J.C. 2007. Fisheries Management: Progress towards Sustainability. Blackwell Publishing.
- Panyatu, T. 1982. Management Concepts for Small Scale Fisheries: Economic and Social Aspects, FAO Fisheries Technical Paper number 228, FAO, Rome
- Ross, R. 1998. Fisheries Conservation and Management, Fishing News Books, London.
- SOFIA(2022) The State of World Fisheries and Aquaculture, FAO Fisheries and Aquaculture Department.<http://www.fao.org/publications/sofia/2020/en/>

24-308-0305 MARKETING MANAGEMENT (3 Core)

Course Outcome (CO) : After completing the course, students will be able to

CO1- Understand the trends and challenges in marketing concepts for marketing decision making process

CO2- Apply the marketing strategies in the seafood and aquaculture marketing

CO3- Analyse the trends, challenges and in seafood export marketing

CO4-Evaluate the international seafood trade and export from India

CO5- Create promotion tools for marketing seafood.

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2
CO2	2	2	2	2
CO3	2	2	2	2
CO4	3	2	3	2
CO5	3	2	2	2

Module1: Introduction to Marketing

Nature and scope of Marketing-Marketing Vs selling- Core marketing concepts –Company orientation toward the market place- Consumer markets and Business markets- Marketing Mix, Market Environment Scanning –Marketing Information System, Market Research, Identifying target segments and selecting target markets and market positioning, consumer behaviour

Module 2: Product and Place

Product Concept and definitions-Different levels of product-Product mix-product line-product life cycle - New product development -Branding and packaging decisions

Channel management -Types of Channel, selection, co-operation and conflict management - vertical, horizontal and multi-channel systems.

Module 3: Price and Promotion

Promotion mix - Advertising, Sales promotion, Public relations, personal selling and direct marketing; Digital Marketing - Green marketing

Pricing: major factors influencing pricing-pricing methods and strategies.

Module 4: International Marketing

The trends in International seafood trade-Major global markets for seafood, India's share in international seafood trade- Indian seafood trade-Implications, issues and policy imperatives-

Seafood trade policies in India – export promotion measures, Foreign trade policy- ITC Code for marine products, Exim policy, Special focus initiatives in marine products trade,

General provisions regarding imports and exports, Export Promotion Capital Goods (EPCG) Scheme.

Access issues in International Markets - Complexities and regulations in International marketing- WTO, Free Trade Agreement (FTA), Sanitary and Phyto Sanitary (SPS) Measures and Technical Barriers to Trade (TBT), Tariff barriers- Antidumping Duty, Countervailing Duty (CVD), Rejections.

Non-tariff barriers (NTB) -Import bans, quotas, Complex/discriminatory Rules of Origin, Quality conditions imposed by the importing country on the exporting countries, SPS, Unreasonable packaging, labelling, product standards-eco labelling, catch certification

Module 5: Export Documentation

Export Documents - Contract/Order, INCO Terms, Invoices, Transport Documents- Bills of Lading, Airways Bill, Statutory Requirement: Excise, Customs and Port Formalities for Export Shipment, Foreign Exchange Rules, Document and Exchange Control. Statutory requirements; Excise, Customs and Port formalities for export shipment, Foreign exchange rules.

Method of payment in international trade; Documentary credit (Letter of credit-LOC) UCPDC 500. Negotiation of Export Bills and collection of sales proceeds, Pre-post shipment credits, bank guarantees.

Standardised Documentation through electronic mode , Introduction to ICEGATE, Bill of entry through ICEGATEVsystem, Introduction to H S code of commodity classification. Duty drawback, Central Excise Rebate and Bond System, Income tax concession and other tax incentives.

Procedural and Documentary formalities as per Import Policy of India for Duty Exemption SchemeEPCG, SEZ/100%EOU/EHTP/STP. Deemed Exports Status Holders (EH/TH/STH/SSTH)

Suggested Reading

- Stanton, 1984. Fundamentals of marketing, McGraw Hill book Co. New Delhi
- Keegan, W.J.(1995). *Global Marketing Management*. Prentice Hall New Delhi.
- Vern Terpstra, Ravi Sarathy (2000) International Marketing Dryden Press2000 Pennsylvania State University ISBN0030211123, 9780030211126., 753p
- Philip Kotler, 2001. A Framework for Marketing Management, Prentice-Hall, Inc. A Pearson Education Company Upper Saddle River, New Jersey 07458
- Sirachy, R. And V.Terpstra. (2006). *International Marketing*. Prentice Hall. New Delhi
- Francis Cherunilam, F. 2010. International Marketing, Himalaya Publishing House Ltd.12th edition.
- Francis Cherunilam (2012). *International Trade and Export Management*, Himalaya Publishing House.
- Czinkota, M.R. (2012). *International Marketing*, 10thEdn. Cengage Learning. Boston
- Majaro, Simon (2012): International Marketing: A Strategic Approach to World Markets, 316p
- Export Import Policy: Ministry of Commerce. Government of India
- Philip R. Cateora, Mary C. Gilly, John L. Graham (2017): International Marketing, Mc Graw Hill India, 2017.
- Kotler, P. and Keller, K.L. (2012) Marketing Management. 14th Edition, Pearson Education.

24-308-0306 ECONOMICS OF SUSTAINABLE FISHERIES DEVELOPMENT (3 Core)

Course Outcome (CO) : After completing the course, students will be able to

- CO1. Discuss economic growth, economic development, measurement of National Income and the indicators for sustainable economic development.*
- CO2. Sketch the structure and dynamics of economic significance of sustainable fisheries development.*
- CO 3 Understand the concept and importance of sustainability and its historical evolution.*
- CO4. Discuss the significance of SDGs and the implications of Sustainable Fisheries Development.*
- CO5. Apply the theoretical knowledge about sustainable Fisheries development into practical situations.*

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3
CO2	3	2	2	2
CO3	3	3	3	3
CO4	3	2	3	2
CO5	3	2	2	3

Module 1 Economic development and growth

Macroeconomics, National Income and Related Aggregates, Measurement of National Income. GNP as a measure of economic growth, Balance of Payment and Balance of Trade, Business Cycle, Sustainable Development, Green GNP. Limits to Growth.

Module 2 Indicators of development

Role of fisheries in economic development, Characteristics of developing and developed economies; Theories of development; Role of economic, technological, social, cultural, political and environmental factors; interdependence between fisheries and industrial development.

Module 3 Introduction to Sustainable Development

Glimpse into History and Current practices - Broad introduction to SD - its importance, need, impact and implications; definition coined; evolution of SD

perspectives over the years; recent debates; 1987 Brundtland Commission and outcome; later UN summits and outcome.

Module 4 : Conceptual and Theoretical framework

Conceptual and Theoretical framework of sustainable development, Sustainable Development Goals- Features of the 2030 Agenda for Sustainable Development- Interrelationships of SDGs- Implementation of sustainable fisheries development goals, Sustainable Fisheries Development.

Module 5: Analytical Frameworks of Sustainability

Analytical frameworks in sustainability studies, sustainability indicators; the significance of quantitative and qualitative assessments of sustainability; and measuring sustainable economic development; Critical Perspectives on Sustainable Fisheries Development, Fisheries Resource management and implications on sustainable development.

Suggested Reading

- Chakaravathi RM. 1986. Under Development and Choices in Agriculture. Heritage Publ., New Delhi.
- Dewett K K. 2002. Modern Economic Theory. S. Chand & Co.
- M.L. Jhingan Economics of Development and Planning
- Dutta and Sundaram Indian economy
- Todaro, Michael P. and Stephen C. Smith, Economic Development, Pearson.
- Peter. P. Rogers, Kazi. F. Jala and John. A. Boyd (2007), An Introduction to Sustainable Development, Earthscan Publication Ltd, United Kingdom.
- World Commission on Environment and Development (1987). "Our Common Future: Report of the World Commission on Environment and Development".
- Nations, U. (2015). Transforming our world: The 2030 agenda for sustainable development. New York: United Nations, Department of Economic and Social Affairs.

ELECTIVES

1. SUSTAINABLE AQUACULTURE (3 credit)

Course Outcome (CO) : After completing the course, students will be able to

CO1- Understand major aquaculture practices.

CO2- Apply prestocking, stocking and post stocking management of aquafarms

CO3- Provide expertise aqua farm dynamics and judge suitability of sites for farms and cages

CO4- Contribute to aquaculture production enhancement

CO5- Develop sustainable farming protocols

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2
CO2	3	3	2	1
CO3	3	3	3	1
CO4	3	3	2	2
CO5	2	2	2	2

Module 1: Introduction

Current status, trends and scope of Indian aquaculture production and consumption; Challenges of aquaculture in India; Future of inland, coastal and open sea aquaculture in India; Employment in aquaculture sector.

Module 2: Aquaculture systems, Engineering and Aquarium keeping

Extensive, semi-intensive and intensive culture of fish, Pen and cage culture in lentic and lotic water bodies, polyculture, composite fish culture, paddy cum fish culture, Pokkali shrimp farming Pond culture, raceways, aquaponics, Cage and pen culture.

Aquaculture engineering -Technical components of farm designing, site selection and evaluation, construction of bunds, dykes etc; Hydrodynamics; rates of discharge and types of flows, design, components and construction of tanks, ponds and cages. Aquatic environment- abiotic and biotic factors of aqua farms

Aquarium keeping: Design and construction of tanks; Aquarium fabrication; setting and maintenance; Aquascaping.

Module 3: Pre stocking and post stocking management

Preparation of ponds; Monitoring food availability; Primary and secondary production; Role of microbes in regeneration of nutrients; Assessing plankton and benthic production; supplementary feeding; water quality management; assessment of growth and standing crop.

Module 4: Nutritional requirements of fish and shell fish

Feed formulations– farm made feeds, formulated feeds; feed formulation methods; different types of feed; Feed properties evaluation-FCR, SGR, PER etc.; Feed additives, binders and nutraceuticals; Microbound- microencapsulated feeds- Storage properties of formulated feed; Toxins in feed.

Module 5: Farm Management

Fin fish aquaculture- carps, catfishes, Hilsa, seabass, milkfish, mullets, pearl spot, sea breams, rabbit fish, grouper, yellowtail, eel, cobia, salmon, flatfish; Fish diseases- Prevention, control and treatment.

Crustacean aquaculture: Shrimp farming (*Penaeus monodon*, *P. indicus*, *P. semisulcatus*, and *Litopenaeus vannamei*)- systems of farming, pond preparation, stocking, feed and water quality management, harvesting and handling; Mud crab fattening; production of soft-shell crab; Infectious bacterial and viral diseases: General characteristics, epizootiology, diagnosis, prevention, control and treatment

Culture of marine mollusks: culture of mussels, oysters, pearl oysters, scallops, clams, cockles, abalones; Rearing methods - Raft and rack culture; off-bottom and on-bottom culture.

Seaweed culture: Major seaweed species of commercial importance; methods of culture; farming of agar, algin, carrageenan yielding species

Suggested reading

- Bardach, J. E. 1997. Sustainable Aquaculture. John Wiley & Sons. 251p
- De Silva, S.S and. Anderson T.A 1995. Fish Nutrition in Aquaculture. Chapman & Hall Aquaculture Series. 320p
- Diwan, A.D., Joseph, S and Ayyappan S. 2008. Physiology of Reproduction, Breeding and Culture of Tiger Shrimp. Narendra Publ. House. 292p.
- Elena M. 2003. Nutrition, Physiology and Metabolism in Crustaceans. Science Publishers. 160p.
- Guillame, J., Kaushik, S., Bergot, P. and Metallier, R. 2001. Nutrition and Feeding of Fish and Crustaceans. Springer Praxis Publ. 408p.
- Hagiwara, A., Snell, T.W., Lubzens, E. and Tamaru C.S. 1997. Live Food in Aquaculture. Proceedings of the Live Food and Marine Larviculture Symposium. Kluwer. 328p.
- Halver, J. and Hardy R.W. 2002. Fish Nutrition. Academic Press. 726p
- Halver, J.E and Tiwies, K.T. 1979. Finfish Nutrition and Fish feed Technology. Vols. I, II Heenemann, Berlin. 75-85pp
- Hertrampf, J.W and Pascual F.P. 2000. Handbook on Ingredients for Aquaculture Feeds. Kluwer. 573p
- Holmer, M, Black, K., Duarte, Marba C. M N. and Karakassis, I. (Eds.). 2008. Aquaculture in the Ecosystem. Daya Publ. House. 326p.
- ICAR. 2006. Handbook of Fisheries and Aquaculture. ICAR. 850p
- Jhingran, V.G. 1991. Fish and Fisheries of India. Hindustan Publ.
- Leung, P., Lee, C.S. and O'Bryen J.P. (Eds.). 2007. Species and System Selection for Sustainable Aquaculture. Blackwell Publ. 528p
- Midlen and Redding T.A. 1998. Environmental Management for Aquaculture. Chapman & Hall. 224p
- MPEDA., 1993. Handbook on Aqua Farming - Live Feed. Micro Algal Culture. MPEDA Publication. 61p

- Muthu, M.S. 1983. Culture of Live Feed Organisms.Tech. Paper 14.Summer Institute in Hatchery Production of Prawns Seeds. CMFRI, Cochin.PP-13p
- Nair, P.R. 2008. Biotechnology and Genetics in Fisheries and Aquaculture. Dominant Publ. 308p
- Ojha, J.S. 2005.Aquaculture Nutrition and Biochemistry.Daya Publ.236p
- Pandian, T.J, Strüssmann, C.A. and Marian, M.P. 2005.Fish Genetics and Aquaculture Biotechnology. Science Publ.P-170p
- Pillay T.V.R. 1972. Coastal aquaculture in the Indo – Pacific region, Fishing News. FAO of United Nations, Rome,P- 566p
- Pillay, T.V.R and Kutty M.N. 2005. Aquaculture: Principles and Practices. 2nd Ed. Blackwell.P- 640p
- Pillay, T.V.R. and Kutty M.N. 2005.Aquaculture- Principles and Practices. Blackwell. 624p
- Rajagopalsamy, C.B.T. and Ramadhas, V.2002. Nutrient Dynamics in Freshwater Fish Culture System.Daya Publ. 140p
- Rath, R.K. 2000.Freshwater Aquaculture.Scientific Publ. 597p
- Santhanam, R. 1990. Coastal aquaculture in India.CBS Publications. 174p
- Selvamani, B.R and Mahadevan, R. 2008. Aquaculture, Trends and Issues.Campus Books International. 284p.
- Sharma, L.L., Sharma, S.K., Saini, V.P. and Sharma B.K. 2008.Management of Freshwater Ecosystems. Agrotech Publ. Academy.
- Walker, P. and Subasinghe, R.P (Eds.). 2005. DNA Based Molecular Diagnostic Techniques: Research Needs for Standardization and Validation of the Detection of Aquatic Animal Pathogens and Diseases. FAO Publ. 167-191 pp.
- Avnimelech, Y (2015) Biofloc technology- a practical guide.World Aquaculture Society. 258p
- Harvey, B., Soto, D., Carolsfeld, J. and D.M.Bartley (2017) Planning for aquaculture diversification. The importance of climate change and other drivers. FAO Rome, 156p
- Samocha, T.M. (2019) Sustainable biofloc systems for marine shrimp. Academic Press, Elseiver. 432p

2. QUALITY ASSURANCE AND FOOD SAFETY FOR SEAFOOD INDUSTRY (3 credit)

Course Outcome (CO) : After completing the course, students will be able to

CO1. Understand the concept of quality assurance and food safety for managing a seafood business.

CO 2. Demonstrate the factors responsible for the physical, chemical and microbiological quality of water, ice and seafood

CO3. Analyze the quality management system applicable for each stage of product movement from harvesting to end consumer..

CO4. Apply the techniques of quality assurance in product safety, traceability and factory auditing for producing safe seafood for international markets.

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3
CO2	3	3	2	2
CO3	3	3	1	3
CO4	3	3	1	2

Module 1. Quality Assurance

Quality, Quality assurance, Quality management, total quality concept and application in fish trade. Quality assessment of fish and fishery products - physical, chemical, organoleptic and microbiological Quality standards. Quality Assurance. Food Safety: Definition, Factors affecting Food Safety, Important considerations for Seafood Safety. Hazards in Seafood. Physical, chemical and microbiological.

Module 2. Physical hazards and Chemical hazards

Chemical contaminants in seafood-Biological toxins occurring in sea foods: Scombroid poisoning, histamine poisoning, shell fish poisoning, ciguatera poisoning, puffer fish poisoning etc dioxins, biogenic amines, Lethal dose, LD50, pesticides, herbicides, antibiotics, heavy metals and other chemical hazards in cultured and wild caught aquatic foods. Sources of contamination, permitted levels and preventive measures. Food additives. Physical hazards in seafood and its limits.

Module 3 Biological Hazards

Sources of microorganisms in food. Importance and significance of microbes in food. Intrinsic and extrinsic factors in food affecting growth of microorganisms. Intestinal beneficial bacteria. Food bio preservatives, ingredients, and enzymes of microbial origin. Bacteria, viruses, parasites, fungal hazards associated with seafood, Morphology, Sources of contamination, symptoms and diseases, toxins associated with food infections by bacteria. Limits & Preventive measures. Fungal organism in food–toxins and preventive measures. Parasites and viruses associated with seafood and preventive measures.

Module 4- Food borne disease

Types of microbial food borne diseases- intoxication, (Staphylococcal intoxication, botulism, mycotoxicosis) infections (salmonellosis, listeriosis, pathogenic *Escherichia coli*, shigellosis, gastroenteritis by *Vibrio* species, enteric viruses) and toxico-infections (*Clostridium perfringens*, gastroenteritis, *Bacillus cereus*, cholera). Human factors in food borne disease symptoms- human gastrointestinal order, epidemiological aspects, predominant etiological agents, bacterial pathogens in foods. Pathogenic viruses, food borne protozoan parasites, yeasts and molds. New pathogens and emerging food borne diseases. Process water quality in fish processing industry, product quality, water analysis, treatments, chlorination, ozonisation, UV radiation, reverse osmosis, techniques to remove pesticides and heavy metals.

Module 5. Quality Assurance & Certification

Total quality management; Good Manufacturing Practices, Good Laboratory Practices, Quality Management systems QSS. Quality Circles, SQC, ISO System, Codex Alimentarius commission. HACCP, Principles, Implementation. Plan Documentation, types of record. Auditing, Surveillance; Audit, Mock audit, third party quality certifying audit, Auditors and Lead auditors. Certification procedures, certifying bodies, Accrediting bodies, International bodies.

National and international laws and regulations- regulatory agencies-International standards-ISO 9000 series of quality systems-Traceability issues in seafood production chain- Methods, good traceability practice, principle methods for the validation of traceability.

Suggested Readings:

Alasavar, C and Taylor. 2002. Seafoods-Quality, Technology and Nutraceutical Applications, Springer.

- Anon, 1985. Standard methods for the examination of water.Waste water, 16th edition APHA.AWWA.
- Connell, J. J., 1995. Control of fish quality. Fishing news books.
- EIA, 2005. Scheme for approval and monitoring of Establishments/factory vessels/ Freezer vessels Processing/storing Fish & fishery products For export Document No. EIC/F&FP/Ex. Inst./Issue 3,256p.
- EIA, 2012. Executive instructions for approval and monitoring of fish & fishery products for export Document No EIC/F &FP/Ex.Inst./March/2012/Issue 4,342p.
- Gopakumar, K. 1993. Fish packaging technology. Concept Publishing Company, New Delhi.
- Huss, H. H., Jakobsen, M. and Liston, J. 1991. Quality assurance in the fish industry. Elsevier Publishing, London, New York.
- Iyer, T. S. G. 2007. HACCP systems for food industries. Edn. (1),Publ. by TSG Iyer, Patterimadam, Thripunithura, 143p.
- Iyer, T. S. G., Kandoran., M. K., and Thomas Mary. 2000. Quality assurance in seafood industry, CIFT, Kochi, 239p.
- John, D. E. V., 1985. Food safety and toxicity - CRC Press, New York.
- Krenzer, R., 1971. Fish inspection and quality control. Fishing News Ltd., London.
- Surendran, P.K., Lalitha., K.V., Nambiar, V.N. and Thanpuran., N. 2006. Laboratory manual on Microbiological Examination of Seafood, CIFT, Kochi, 170p.

3. MANAGEMENT ACCOUNTING AND FINANCE MANAGEMENT FOR FISHERIES (3 credit)

Course Outcome (CO) : After completing the course, students will be able to

- CO 1: Understand the basics of financial management so as to read and understand financial statements*
- CO 2: Apply cost accounting tools for decision making in fisheries business.*
- CO 3: Analyse the financial health of companies using ratio analysis.*
- CO 4: Apply capital budgeting tools for evaluating investment opportunities in fisheries .*
- CO5: Apply financial management techniques in seafood industry*

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	2
CO2	3	-	-	1
CO3	3	1	-	3
CO4	2	2	1	2
CO5	3	3	2	3

Module 1 Introduction to Accounting and Finance

The need for understanding finance and accounting for fisheries professionals. Finance vs Accounting, Definition and significance of finance and accounting, Role of financial accounting in business operations. Basic Principles and Concepts of Accounting.

Module 2 Introduction to Financial Accounting

Overview of financial statements: Balance sheet, income statement, cash flow statement, and statement of changes in equity. Components of each financial statement. Purpose and users of financial statements. Analyzing the balance sheet: Assets, liabilities, and equity. Understanding the income statement: Revenue, expenses, and net income. Assessing cash flow: Operating, investing, and financing activities.

Module 3 Introduction to Cost Accounting :

Definition of cost management. Importance of cost management in business. Role of non-finance professionals in cost management. Fixed costs vs. variable costs. Direct costs vs. indirect costs. Cost estimation. Cost allocation. Cost control. Activity-based costing (ABC). Cost-volume-profit (CVP) analysis. Budgeting and variance analysis. Make or buy decisions. Pricing decisions

Module 4 Introduction to Ratio Analysis :

Definition and significance of ratio analysis. Role of ratio analysis in business evaluation. Importance for non-finance professionals. Liquidity ratios: Current ratio, quick ratio. Solvency ratios: Debt-to-equity ratio, interest coverage ratio. Profitability ratios: Gross profit margin, net profit margin. Efficiency ratios: Asset turnover ratio, inventory turnover ratio. Benchmarking against industry averages. Interpreting deviations from norms. Assessing financial health and stability. Evaluating operational efficiency. Identifying areas for improvement. Supporting decision-making processes.

Module 5. Introduction to Capital Budgeting :

Definition and importance of capital budgeting. Role of capital budgeting in strategic planning. Methods of Evaluating Investment Projects. Payback period method. Accounting rate of return (ARR). Net present value (NPV). Internal rate of return (IRR). Profitability index (PI). Importance of Cash Flows. Time value of money concept. Cash flow estimation. Discounted cash flow (DCF) analysis. Applying capital budgeting techniques to real-world scenarios. Evaluating investment opportunities using case studies. Group discussions and problem-solving exercises

Suggested Reading

Batty J. 1975. Management Accountancy, 4th ed. Macdonald, Evans Ltd.
Bhattacharya S.K. and Dearden, J. 1976. Accounting for Management Test and cases-Vikas Publishing House Pvt Ltd.
Keller, W. and Ferrara, W.L. 1980. Management Accounting for Profit Control Tata McGraw Hill. Publishing Co. Ltd., New Delhi
Kuchal, S.C. 1988. Financial Management, Chaitanya Publishing House, Allahabad
Maheswari, 1991. Principles of Management Accounting Sultan Chand & Sons, New Delhi.
Pandey, I.M. 1989. Financial Management, Vikas Publishing House, Allahabad.
Shukal M.C. and Gerwal, T.S. 1977 Cost Accounts, 7th ed. S. Chand & Co. Ltd., New Delhi

Van Horne, C.J. 2002. Financial Management and policy, 6thed. Prentice Hall of India, New Delhi.

4. SEAFOOD SIDESTREAM VALORIZATION (3 credit)

Course Outcome (CO) : After completing the course, students will be able to

- CO1. To understand the concept of seafood side streams and their significance in the context of sustainable seafood processing.*
- CO2. To explore various techniques for characterizing seafood waste and identifying valuable compounds.*
- CO3. To examine traditional and innovative methods for valorizing seafood side streams in food, pharmaceutical, and other industries.*
- CO4. To evaluate the environmental and economic implications of seafood sidestream valorization strategies.*

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	3
CO2	3	3	2	2
CO3	2	3	2	2
CO4	2	2	1	2

Module 1: Introduction to Seafood Side streams

Definition and classification of seafood sidestreams, Significance of sidestream valorization for sustainability, Global trends and challenges in seafood waste management, Characterization of Seafood Sidestreams, Composition analysis: proteins, lipids, carbohydrates, minerals, and bioactive compounds. Techniques for assessing nutritional and functional properties.

Module 2: Valorization Techniques Extraction and recovery of proteins, lipids, and bioactive compounds. Utilization of seafood sidestreams in food applications (e.g., functional ingredients, flavor enhancers). Biotechnological approaches for converting waste into value-added products.

Module 3: Applications of seafood side stream based products

Pharmaceutical and nutraceutical uses of seafood by-products, Cosmetic and personal care applications, Agricultural and aquaculture applications (e.g., biofertilizers, animal feed)

Module 4: Fish Meal-dry & wet reduction-grades-uses

Fish Oil-industrial production of fish body oil and liver oil-commercial uses. Fish Protein Concentrate-types, preparation and uses. Preparation and uses of chitin, chitosan, glucosamine hydrochloride, pearl essence, squalene, ambergris, fish peptones, fish hydrolases, isinglass, shark finrays, agar, alginic acid and carragenen, Fish sauces and fermented fishery products from seafood. Fish ensilage, fermentation using acids (formic acid/lactic acid) and enzymes, properties, storage and associated changes.

Module 5: Emerging Technologies

Biorefinery concepts for integrated valorization of seafood sidestreams, Nanotechnology and nanomaterials from seafood waste, Advanced separation and purification techniques, Environmental and Economic Considerations, Economic viability and market potential, Regulatory and policy frameworks governing seafood waste utilization. Future prospects and challenges in the field.

Suggested readings

- Balachandran, K. K. 2001. Post-harvest technology of fish and fish products. Daya Publishing House, New Delhi.
- Bligh, E. G. 1992. Seafood science and technology, Fishing News Books.
- Borgstrom, G. 1961. Fish as food Vol. I- IV Academic Press, New York.
- Gopakumar, K. 2002. Text book of Fish Processing Technology. Indian Council of Agricultural Research, New Delhi.

5. VALUE ADDITION OF SEAFOOD (Practical) (1 credit)

Course Outcome (CO) : After completing the course, students will be able to

- CO1. Demonstrate proficiency in preparing fish meal and fish oil from seafood byproducts, as well as in preparing chitin, chitosan, and glucosamine hydrochloride.
- CO2. Apply analytical methods to determine protein, fat, ash, and sand content in fish meal, and interpret analysis results to assess quality.
- CO3. Analyse saponification value, iodine value, acid value, and vitamin content in fish oil, and apply results to evaluate quality.
- CO4. Apply fish meal, fish oil, chitin, chitosan, and glucosamine hydrochloride in various industries.
- CO5. Create practical skills in preparing value-added seafood products such as fish mince, fish cutlets, prawn cutlets, breaded fish, and seafood pickles.

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	3
CO2	3	3	3	2
CO3	1	2	2	2
CO4	3	3	2	3
CO5	3	3	3	3

Module 1: Analysis of Fish Meat Quality

Analytical methods for determining protein, fat, ash, and sand content in fish meal. Interpretation of analysis results to assess fish meal quality.

Module 2: Preparation of Value-Added Seafood Products

Practice in preparing value-added seafood products such as fish mince, fish cutlets, prawn cutlets, breaded fish, and seafood pickle. Preparation of surimi, fish fingers, and fish sausage using mince-based techniques. Production of fish balls and fish paste from seafood byproducts.

Module 3: Marinated Products

Techniques for marinating seafood products to enhance flavor and shelf life.

Module 4: Battered and Breaded Products

Preparation of battered and breaded products from fish fillet, squid, and shrimp. Methods for assessing the quality of battered and breaded seafood products.

Suggested readings

- Alasalvar C, Miyashita K, Shahidi F, Wanasundara U. *Handbook of Seafood Quality, Safety, and Health Applications*. John Wiley & Sons; 2010.
- Bremner HA, editor. *Safety and quality issues in fish processing*. Woodhead Publishing; 2002.

- Chalamaiah, M., Hemalatha, R., & Jyothirmayi, T. (2012). Fish protein hydrolysates: proximate composition, amino acid composition, antioxidant activities and applications: a review. *Food Chemistry*, 135(4), 3020-3038.
- CIFT, 1981. *Proceedings on Summer Institute on Non-Traditional diversified fish*
- Gopakumar, K. 1993. *Fish packaging technology*. Concept Publishing Company,
- Gopakumar, K. 2002. *Text book of Fish Processing Technology*. Indian Council
- Hartmut, R. and Jorg, O. 2009. *Fishery products: quality, safety and authenticity*.
- Kim, S. K., & Mendis, E. (2006). Bioactive compounds from marine processing byproducts—a review. *Food Research International*, 39(4), 383-393.
- Mendis, E., Rajapakse, N., Byun, H. G., & Kim, S. K. (2005). Investigation of jumbo squid (*Dosidicus gigas*) skin gelatin peptides for their in vitro antioxidant effects. *Life Sciences*, 77(16), 2166-217. *New Delhi*.
- Sae-leaw, T., Benjakul, S., & Oey, I. (2019). Bioactive peptides from collagen hydrolysate of cuttlefish (*Sepia pharaonis*) skin: Antioxidant activities and effects on lipid and protein oxidation of fish muscle. *Food Chemistry*, 272, 649-657.
- Shahidi F, editor. *Seafood Processing: Technology, Quality and Safety*. John Wiley & Sons; 2014.
- Shahidi, F., & Synowiecki, J. (1997). Protein hydrolysates from Pacific whiting solid wastes. *Journal of Agricultural and Food Chemistry*, 45(9), 3423-3430.
- Wheaton, F. W. and Lawson, T. B. 1985. *Processing of Aquatic Food Products*. Wiley- Blackwell, USA.

6. QUALITY ASSURANCE AND SEAFOOD MICROBIOLOGY

(Practical) (1 credit)

Outcome

After completing the course, students will be able to

CO1. Understand the sample collection and routine quality control techniques

CO2. Apply the theoretical knowledge in hands-on analysis of seafood quality control

CO3. Apply food microbiology techniques applicable to seafood safety

CO4. Evaluate the HACCP and other modern quality assurance techniques applicable to seafood industry.

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2
CO2	3	3	2	2
CO3	2	2	1	1
CO4	2	3	1	1

Module 1: Introduction to Food Microbiology Laboratory- Laboratory safety guidelines and procedures. Introduction to microbiological media and reagents, Proper aseptic techniques and handling of microbial cultures, Calibration and use of laboratory equipment. Quality characteristics of water, ice and fish.

Module 2: Microbial Enumeration Techniques- Total plate count method for quantification of viable microorganisms in food samples, Pour plate and spread plate techniques for microbial enumeration, Calculation of microbial counts and determination of colony-forming units (CFU/g or CFU/mL), Interpretation of microbial growth on agar plates.

Module 3: Detection of Foodborne Pathogens: Bacterial Isolation-Isolation and identification of common bacterial foodborne pathogens: *Escherichia coli*, *Salmonella*, and *Staphylococcus aureus* etc. Enrichment and selective media for isolation of specific pathogens, Confirmation of bacterial isolates using biochemical tests and serological methods.

Module 4: Analysis of Food Spoilage Microorganisms. Isolation and enumeration of food spoilage microorganisms: yeasts, molds, and lactic acid bacteria. Selective media and

conditions for the isolation of spoilage organisms. Identification of common spoilage microorganisms using morphological and biochemical tests.

Module 5: HACCP: Preparation of HACCP manual. Determination of CCPs of fresh and processed food products. Hygiene and sanitation requirements and assessments. Analysis of food additives, chemical contaminants, physical hazards etc. Preparation of decision tree to establish CCP. Establish Good Manufacturing Practices (GMP) in seafood processing factories. Establishing Good Laboratory Practices (GLP) and Good Hygienic Practices (GHP). Case studies.

Suggested Readings:

Anon, 1985. Standard methods for the examination of water. Waste water, 16th edition APHA. AWWA.

Connell, J. J., 1995. Control of fish quality. Fishing news books.

EIA, 2005. Scheme for approval and monitoring of Establishments/factory vessels/ Freezer vessels Processing/storing Fish & fishery products For export Document No. EIC/F&FP/Ex. Inst./Issue 3,256p.

EIA, 2012. Executive instructions for approval and monitoring of fish & fishery products for export Document No EIC/F &FP/Ex.Inst./March/2012/Issue 4,342p.

Gopakumar, K. 1993. Fish packaging technology. Concept Publishing Company, New Delhi.

Huss, H. H., Jakobsen, M. and Liston, J. 1991. Quality assurance in the fish industry. Elsevier Publishing, London, New York.

Iyer, T. S. G. 2007. HACCP systems for food industries. Edn. (1), Publ. by TSG Iyer, Patterimadam, Thripunithura, 143p.

Iyer, T. S. G., Kandoran., M. K., and Thomas Mary. 2000. Quality assurance in seafood industry, CIFT, Kochi, 239p.

7. CASE STUDY ON FISHING GEAR DESIGN AND OPERATION (1 credit)

Course Outcome (CO) : After completing the course, students will be able to

CO1. Understand and evaluate infrastructure facilities available in fishing harbours, net repair yards and net factories

CO2. Analyse prevailing situations in fishing harbours, landing centres, docks and repair yards for addressing the emerging needs of the fishing industry of the country.

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	2	1	3	2
CO2	3	2	3	1

Module 1:

FIELD VISIT to Fishing Harbors, Fish landing centers, Net making factory and Net repair yards

Report on net making factory and net repair yards.

Module 2:

FIELD STUDY - The student has to visit boat building yards, fishing harbours, docking yards, net manufacturing units and submit comprehensive report on activities connected with fishing craft and gear construction.

Suggested Reading

- Chapelle, H.I. 1994. Boatbuilding: A Complete Handbook of Wooden Boat Construction, W.W. Norton, ISBN 0393035549, 624p.
- Coackley, N. 1991. Fishing Boat Construction: 2 Building a Fiberglass Fishing Boat, Issue 321 of FAO fisheries technical paper, FAO, ISBN 9251031169, 84p.
- Fyson, J.F. (Ed). 1985. Design of small fishing vessels, Fishing News Books, Oxford.
- Ponnambalam, A. 2003. Fishing Craft Technology. CIFNET. Cochin:158p.
- Richard O. N. Riley., Jeremy, M. M. Turner. 1995. Fishing Boat Construction: 3 Building a ferrocement fishing boat, Volume 354 of FAO fisheries technical paper, FAO, ISBN 9251037647, 149p.
- Stokoe, E.A. 1985. Reed's Ship Construction for Marine Students, Volume 5 of Reed's Marine Engineering Series, Thomas Reed Publications, ISBN 0900335955, 192p.
- Baranov, F.I. 1976. Selected Works on Fishing Gear, Commercial Fishing Techniques, Vol.1, Israel Programme for scientific translations, Keter Publishing House Ltd. Jerusalem, 631p.
- FAO 1975. FAO catalogue of small-scale fishing gear, Publ. Fishing News (Books) Ltd., Surrey, England, 191p.
- Klust, G. 1964. Netting twines of polypropylene and polyamide compared. In Modern Fishing Gear of the World 2. Fishing News (Books), Ltd., Surrey, England: 54p.
- Prado, J. 1990. Fisherman's work book, Fishery Industries Division, FAO. Published by Fishing News Books, ISBN 0-85238-163-8. 185p.

8. HATCHERY TECHNIQUES AND AQUACULTURE PRACTICES (Practical) (1 credit)

Course Outcome (CO) : After completing the course, students will be able to

CO1- Develop identification skills for the finfishes and shellfishes used in aquaculture,

CO2- Acquire expertise to analyze various physico-chemical and biological parameters of water and soil

CO3- Understand different types of diseases in aquaculture systems and their diagnostic methods

CO4- Apply feed formulation techniques for feeds used in aquaculture

CO5- Apply advanced techniques in aquaculture systems

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	1
CO2	2	1	-	-
CO3	3	1	1	-
CO4	3	3	2	-
CO5	3	3	3	2

Module 1

Identification of finfishes and shellfishes used in aquaculture.

Equipment used in soil and water analysis; Soil sampling, determination of soil moisture and bulk density; measurement of physical and chemical properties of soil and water-temperature, pH, conductivity, salinity, transparency, turbidity, dissolved oxygen, alkalinity and hardness. Calculation of liming requirements

Module 2

Formulation of fish feed; proximate analysis- moisture, crude protein, crude lipid, ash, Estimation of crude fibre. Live food organisms

Module 3

Different kinds of fertilizers, manures, and fertilizers used in aquaculture

Major diseases – etiology – symptoms- treatment –

Module 4

Design and operation of biological filters.

Setting up of model recirculatory system, aquaponic system, aquarium, aquascaping

Module 5

Design of finfish and shell fish hatcheries

Visit to commercial finfish and shell fish hatchery

Suggested readings

- Adhikari S & Chatterjee DK. 2008. Management of Tropical Freshwater Ponds. Daya Publ.
- APHA, AWWA, WPCF. 1998. Standard Methods for the Examination of Water and Wastewater, 20thEd. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, Washington, D. C.
- Boyd, C. E. and Tucker, C. S. 1992. Water Quality and Pond Soil Analyses for Aquaculture, Alabama Agricultural Experimental Station, Auburn University.
- Boyd CE. 1979. Water Quality in Warm Water Fish Ponds. Auburn University.
- CRC Handbook of Mariculture. 1993. Vol. I. Crustacean Aquaculture (2nd Edition). J.P. McVey (Ed.). CRC Press, Inc., Boca Raton, Florida, USA. 526p. p.61-93.
- FAO. 2007. Manual for Operating a Small Scale Recirculation Freshwater Prawn Hatchery. 8-18pp.
- Hertrampf, J.W and Pascual F.P. 2000. Handbook on Ingredients for Aquaculture Feeds. Kluwer. 573p
- Halver JE & Tiews KT. 1979. Finfish Nutrition and Fish feed Technology. Vols. I, II Heenemann, Berlin.
- ICAR. 2006. Handbook of Fisheries and Aquaculture. ICAR.
- Lavens P & Sorgeloos P. 1996. Manual on the Production and Use of Live Food for Aquaculture. FAO Fisheries Tech. Paper 361, FAO.
- New MB. 1987. Feed and Feeding of Fish and Shrimp. A Manual on the Preparation and Preservation of Compound Feeds for Shrimp and Fish in Aquaculture. FAO – ADCP/REP/87/26.
- Parsons TR, Maita Y & Lalli CM. 1984. A Manual of Chemical and Biological Methods for Seawater Analysis. Pergamon Press.
- Pillay, T.V.R and Kutty M.N. 2005. Aquaculture: Principles and Practices. 2nd Ed. Blackwell.P-640p
- Rajagopalsamy CBT & Ramadhas V. 2002. Nutrient Dynamics in Freshwater Fish Culture System. Daya Publ.
- Sharma LL, Sharma SK, Saini VP & Sharma BK. (Eds.). 2008. Management of Freshwater Ecosystems. Agrotech Publ. Academy.

SEMESTER IV

24-308-0401 ANALYTICS FOR DECISION MAKING IN FISHERIES

(3 Core)

Course Outcomes

After completing the course, students will be able to

CO1 Understand the basic concepts of data management

CO2 Apply various analytical techniques for generating descriptive statistics and visualisation

CO3 Apply parametric and non-parametric tools for decision making in fisheries

CO4 Apply advanced analytical tools for decision making in fisheries

CO5 Apply multivariate tools for decision making in fisheries

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	2
CO2	3	1	-	1
CO3	3	1	-	1
CO4	3	1	-	1
CO5	3	1	-	1

Module 1: Introduction to Data Management

Introduction to various analytical software's and its features. Importing data from different file formats. Data cleaning and preparation techniques. Data transformation and recoding procedures. Variable selection and filtering

Module 2: Descriptive Statistics and Data Visualization using software

Generating descriptive statistics. Generating frequency distributions and histograms. Creating bar charts, pie charts, and scatterplots. Customizing chart properties and formatting options. Using multiple templates for graphical representation. Interpretation of descriptive statistics and graphical summaries

Module 3: Inferential Statistics: Parametric Tests and Non Parametric Tests using software

Assumptions and limitations of parametric tests. Performing t-tests for comparing means of two groups. Conducting one-way and factorial ANOVA. Performing simple and multiple

linear regression analysis. Interpretation of output and drawing conclusions from parametric analyses. Performing non-parametric tests (e.g., Mann-Whitney U test, Kruskal-Wallis test).

Module 4: Inferential Statistics: Advanced Techniques using software

Understanding correlation: definition and significance. Types of correlation coefficients (e.g., Pearson, Spearman). Running the correlation analysis. Interpreting correlation coefficients: strength and direction of relationships. Understanding regression analysis: concepts and applications. Types of regression models (e.g., simple, multiple). Assumptions of regression analysis. Data preparation. Checking linearity. Running the test and interpretation of the output.

Module 5: Multivariate Analysis using software

Data considerations for Factor Analysis. Applying factor analysis to derive factors. Data considerations for conducting conjoint analysis. Running the test and interpreting the results. Time series analysis techniques (e.g., forecasting, decomposition).

Suggested Reading

Business Analytics for Decision Making 1st Edition, Kindle Edition by Regi Mathew 2024, Pearson

Statistical Methods for Research: A Step-by-Step Approach Using IBM SPSS Paperback – 1 January 2021 by K. Kalyanaraman; Hareesh N. Ramanathan; P.N. Harikumar, 2021, Atlantic.

EXCEL 2024: The All In One Step-by-Step Guide From Beginner To Expert. Discover Easy Excel Tips & Tricks to Master the Essential Functions, Formulas & Shortcuts to Save Time & Simplify Your Job by Mike Wang. 2024, Amazon.

R Programming: R Basics for Beginners: 1 Paperback –2023 by Andy Vickler (Author). Ladoo Publishing LLC

DATA ANALYSIS USING SPSS: Text and Cases, For Researchers, Teachers and Students Paperback – 1 January 2022 by Dr. Lalit Prasad (Author), Dr. Priyanka Mishra (Author). Nirali Prakashan

24-308-0402 DISSERTATION/PROJECT REPORT EVALUATION (8 Core)

Students have to undertake research work in aquaculture, fishery biology, fishing technology, fish processing technology, fisheries economics and fisheries business management. They have to submit a dissertation/ project report at the end of their research.

24-308-0403 COURSE VIVA-VOCE (1 Core)

The course viva for an Industrial Fisheries PG program serves as a comprehensive assessment of students' understanding and knowledge gained throughout the program. It typically involves a panel of faculty members or industry experts who evaluate students' mastery of key concepts, theoretical frameworks, practical applications, and critical thinking skills related to industrial fisheries. During the viva, students may be asked to discuss topics such as fishery management strategies, technological advancements in fishing gear and methods, sustainable fishing practices, market trends and challenges, regulatory frameworks, and economic considerations within the fishing industry. The viva provides an opportunity for students to demonstrate their expertise, articulate their insights, and engage in scholarly discourse relevant to industrial fisheries, thereby preparing them for professional roles in the field.

ELECTIVES

1. INTERNSHIP IN SEAFOOD INDUSTRY AND REPORT EVALUATION (4 credit)

Course Outcome

After the successful completion of the course, students will be able to

CO1. Apply principles of seafood supply chain management in real-world settings.

CO2. Evaluate and ensure seafood quality using sensory, microbiological, and biochemical analysis techniques.

CO3. Develop and implement Good Manufacturing Practices (GMP) and Hazard Analysis and Critical Control Points (HACCP) principles in seafood processing.

CO4. Demonstrate knowledge of waste management and effluent treatment methods specific to seafood processing units.

CO5. Acquire technical skills in seafood processing and marketing relevant to the industry.

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	3
CO2	3	3	3	2
CO3	3	3	3	2
CO4	2	3	3	3
CO5	3	3	2	3

Students are expected to have hands-on-experience on various aspects of supply chain in the production and marketing of seafood.

Students should undergo training in quality assurance and management including training in organoleptic quality, microbiology and bio-chemical analysis with respect to national and international standards.

Students should have thorough understanding on the GMP / HACCP and other quality management systems including preparation of HACCP manual and Export Documentation procedures.

Students should also learn waste management/ treatment practices and various systems of effluent treatment methods used in seafood processing units.

2. INTERNSHIP IN AQUACULTURE INDUSTRY (4 credit)

Course Outcome (CO) :

After completing the course, students will be able to

CO1- Apply principles of aquaculture and hatchery management in real time.

CO2- Acquire hands-on training in hatchery operations and management

CO3- Acquire hands-on training in the grow-out culture activities in finfishes and shellfishes

CO4- Establish to operate different types of equipment used in hatchery and grow out farms

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1
CO2	3	3	2	2
CO3	3	3	2	2
CO4	3	3	2	1

Students are expected to have hands-on-experience on various aspects of fin fish/ shell fish hatchery management, seed production and seed marketing.

They may also undergo training in prestocking and post stocking management, harvesting and marketing in aquafarms.

3. STARTUPS AND BUSINESS INCUBATION IN FISHERIES (1 credit)

Course Outcome

After the successful completion of the course, students will be able to

CO1: An understanding of the underlying principles and concepts behind startup ventures and business incubation in the fisheries industry.

CO2: Evaluate the effectiveness and impact of startup and incubation programs in fostering entrepreneurship and economic development in the fisheries sector

CO3: develop creative solutions and proposals for enhancing startup support and business incubation initiatives in fisheries.

CO/PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3
CO2	3	3	3	2
CO3	3	3	3	2

This exciting elective course on Startups/Business Incubation Initiatives in Fisheries is specifically designed for students who harbor a passion for entrepreneurship and aspire to make a splash in the dynamic world of fisheries.

In today's rapidly evolving business landscape, entrepreneurship presents a gateway to creativity, innovation, and impactful change. This elective offers a unique opportunity to channel the entrepreneurial spirit into the realm of fisheries, a sector ripe with potential for disruption and growth.

This course combines technical expertise with business acumen, providing the students with the necessary tools to thrive as fisheries entrepreneurs. Whether envisioning launching their own startup or exploring business incubation opportunities, this course is tailored to fuel students' entrepreneurial ambitions.

The experienced instructors from the school and the industry experts are committed to providing mentorship and support, ensuring that the students have access to the resources and guidance needed to transform ideas into successful ventures.

4. MASSIVE OPEN ONLINE COURSE (MOOC) (2 credit)

Students are expected to successfully complete one MOOC from UGC Swayam/NPTEL/Other online courses of repute conducted by national/international universities/institutes.
