**DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,**
**CHHATRAPATI SAMBHAJINAGAR.**

NAAC- 'A $^{+}$' Grade

**CIRCULAR NO.SU/ B.Sc./NEP-2020/91/2026**

It is hereby inform to all concerned that, the Revised syllabi prepared by the Board of Studies/Ad-hoc Boards/Committees and recommended by the Faculty of Science & Technology, **Academic Council at its meeting held on 02nd June 2026 has accepted** the following **Revised syllabi of Bachelor of Science & Basket** under the Faculty of Science & Technology **as per Norms of National Education Policy-2020 and as per Government Letter dated 13 March 2024** run at the Affiliated Colleges, Dr.Babasaheb Ambedkar Marathwada University as appended herewith.

| Sr.No. | Courses | Semester |
|---|---|---|
| 1. | B.Sc.Botany | Vth and VIth semester |
| 2. | B.Sc.Biotechnology | Vth and VIth semester |
| 3. | B.Sc.Zoology | Vth and VIth semester |
| 4. | B.Sc.Agrochemical and Fertilizer | Vth and VIth semester |
| 5. | B.Sc.Geology | Vth and VIth semester |
| 6. | B.Sc.Environmental Science | Vth and VIth semester |
| 7. | B.Sc.Home Science | Vth and VIth semester |
| 8. | B.Sc.Diary Science and Technology | Vth and VIth semester |
| 9. | B.Sc.Automobile Technology | Vth and VIth semester |
| 10. | B.Sc.Physics | Vth and VIth semester |
| 11. | B.Sc.Chemistry | Vth and VIth semester |
| 12. | B.Sc.Analytical Chemistry | Vth and VIth semester |
| 13. | B.Sc.Polymer Chemistry | Vth and VIth semester |
| 14. | B.Sc.Electronics | Vth and VIth semester |
| 15. | B.Sc.Forensic Science & Cyber Security | Vth and VIth semester |
| 16. | B.Sc.Microbiology | Vth and VIth semester |
| 17. | B.Sc.Fisheries Science | Vth and VIth semester |
| 18. | B.Sc.Mathematics | Vth and VIth semester |
| 19. | B.Sc.Forensic Science | Vth and VIth semester |
| 20. | B.Sc.Information Technology | Vth and VIth semester |
| 21. | B.Sc.Horticulture | Vth and VIth semester |
| 22. | B.Sc.Networking & Multimedia | Vth and VIth semester |
| 23. | B.Sc.Biochemistry | Vth and VIth semester |
| 24. | B.Sc.Industrial Chemistry | Vth and VIth semester |
| 25. | B.Sc.Bioinformatics | Vth and VIth semester |

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|---|---|---|
| **26.** | **B.Sc.Instrumentation Practice** | **Vth and VIth semester** |
| **27.** | **B.Sc.Non-Conventional and Conventional Energy** | **Vth and VIth semester** |
| **28.** | **B.Sc.Statistics** | **Vth and VIth semester** |
| **29.** | **B.Sc.Computer Science** | **Vth and VIth semester** |
| **30.** | **Bachelor of Computer Application** | **Vth and VIth semester** |

This is effective from the Academic Year 2026-27 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.
REF.NO.SU/AC.No.06/4498-113
Date:- 12.06.2026.

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*Deputy Registrar,*
*Syllabus Section*

**Copy forwarded with compliments to :-**

1] **The Principal of all concerned Colleges,**
Dr. Babasaheb Ambedkar Marathwada University,
2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

**Copy to :-**

**1] The Director, Board of Examinations & Evaluation,** Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
2] The Section Officer,[B.Sc.Unit] Examination Branch, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
3] The Programmer [Computer Unit-1] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
4] The Programmer [Computer Unit-2] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
5] The In-charge,[E-Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
6] The Public Relation Officer, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
7] The Record Keeper, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

**DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,**
**CHHATRAPATI SAMBHAJINAGAR (MAHARASHTRA) INDIA -431001**

**B.Sc. Degree Programme**

**(Three Year/Four (Hons)/Four Year (Hons with Research)**

# Course Structure

**(ASPER NEP-2020)**

**Subject (Major): FISHERY SCIENCE**

**Effective from 2026-2027**

Chairman
B.O.S.in Fisheries

Professor Bhaskar Sathe,
Dean,
Faculty of Science & Technology,
Dr.Babasaheb Ambedkar
Marathwada University,
Chhatrapati Sambhajinagar

# Dr. Babasaheb Ambedkar Marathwada University
## Chhatrapati Sambhajinagar

NAAC Re-Accredited A+ Grade

**LIST OF BOARD MEMBERS IN THE STUDIES OF FISHERY SCIENCE (YEARS -2026-27)**

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**The B.O.S.**

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## PREFACE

Poised at the beginning of a transformative chapter in higher learning, the implementation of the National Education Policy (NEP) 2020 lights the way toward a more comprehensive, equitable, and forward-thinking academic environment. This Bachelor of Science (B.Sc.) syllabus has been redesigned to embody the spirit of this policy, focusing on empowering students with the analytical mindset, technical expertise, and core ethics required to succeed in our rapidly evolving modern world."

A Multidisciplinary & Learner-Centric Vision: At its core, the NEP-2020 envisions an educational framework that is fundamentally learner-centric. This curriculum breaks down traditional academic silos, encouraging the integration of knowledge across scientific domains. By offering a diverse array of courses and incorporating interdisciplinary studies, the program nurtures well-rounded graduates capable of addressing complex, real-world challenges with agility and multidisciplinary insight.

Emphasis on Experiential Learning: The curriculum is strategically designed to shift from rote memorization to experiential learning and research. Recognizing the importance of practical engagement, it prioritizes: Laboratory & Field Exploration: Deepening understanding through direct observation. Internships & Project-Based Learning: Cultivating professional skills and a spirit of inquiry. Hands-on Application: Empowering students to apply theoretical concepts in practical, real-world settings.

Commitment to Inclusivity and Equity: Integral to this framework is a steadfast commitment to equity and access. The B.Sc. curriculum reflects this by embracing a diversity of perspectives and backgrounds, fostering an inclusive learning environment. We aim to create a space where every student feels valued, supported, and empowered to reach their full potential, regardless of their starting point.

Ethics, Sustainability, and Global Citizenship: Beyond technical expertise, the curriculum emphasizes the cultivation of ethical values and social responsibility. By integrating studies in environmental sustainability, ethics, and social sciences, the program aims to produce graduates who are not only proficient scientists but also compassionate leaders. Our students are encouraged to develop a sense of accountability toward society and the planet, embodying the spirit of global citizenship.

Towards an Enlightened Society: As we embark on this journey of educational transformation guided by NEP-2020, this B.Sc. curriculum stands as a testament to our collective vision of a more equitable and enlightened society. Through rigorous academics and innovative pedagogy, we strive to inspire the next generation of scientists and change-makers to contribute meaningfully to the advancement of knowledge and the betterment of humanity.

**Structure of B. Sc. (Three / Four Years Honours / Honours with Research Degree) Programme with Multiple Entry and Exit Options**
**Subject (Major): Fishery Science**
**B. Sc. Third Year: V$^{th}$ Semester**

| Course Type | Course Code | Examination Code (To be given by respective BoS) | Course Name | Teaching Scheme (Hrs / Week) | | Credits Assigned | | Total Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory | Practical | Theory | Practical | |
| Major ( Core) Mandatory DSC | SUB/DSC/T /300 | SAC03113 005T | Modern Trends in Fishery Science-I | 2 | | 2 | | 2+2+2+ 2=08 |
| | SUB/DSC/T /301 | SAC03113 015T | Fish Technology and Processing | 2 | | 2 | | |
| | SUB/DSC/P/ 326 | SAC03113 265P | Practical based on SUB/DSC/T/300 | | 4 | | 2 | |
| | SUB/DSC/P/ 327 | SAC03113 275P | Practical based on SUB/DSC/T/301 | 2 | 4 | 2 | 2 | |
| | SUB/DSC/T /302 | | IKS-1 ( Indian Knowledge System related to Major) | | | | | |
| Discipline Specific Electives ( DSE) (Choose any one from SUB/DSE/T/300 and SUB/DSE/T/301) And corresponding Practicals | SUB/DSE/T/ 3 00 | | Ornamental Fish Production | 2 | | 2 | | 2+2=4 |
| | SUB/DSE/T/ 301 | | Fresh water Prawn Culture | 2 | | 2 | | |
| | SUB/DSE/P/ 326 | | Practical based on SUB/DSE/T/300 | | 4 | | 2 | |
| | SUB/DSE/P/ 327 | | Practical based on SUB/DSE/T/ 301 | | 4 | | 2 | |
| Minor (Choose any two from pool of Courses) It is from different discipline of the same faculty | SUB/Mn/T/ 30 0 | | Integrated Fish Farming System | 2 | | 2 | | 2+2=04 |
| | SUB/Mn/T/ 301 | | Waste Management and Co-product System | 2 | | 2 | | |
| **VSC** (Vocational Skill Courses) (Choose any one from SUB/VSC/T/30 0and SUB/VSC/T/ 301)And corresponding Practicals | SUB/VSC/T /3 00 | | Fish Feed Formulation | 2 | | 2 | | 2+2=04 |
| | SUB/VSC/T / 301 | | Fundamental of Fish Microbiology | 2 | | 2 | | |
| | SUB/VSC/P/ 326 | | Practicals based on SUB/VSC/T/300 | | 4 | | 2 | |
| | SUB/VSC/P/ 327 | | Practicals based on SUB/VSC/T/ 301 | | 4 | | 2 | |
| OJT/ FP/CEP/CC/RP (Choose anyone from pool of courses) | SUB/FP/CE P/ P/326 | | Aquaculture and Farm Management | | 4 | | 2 | 02 |
| | | | | **12** | **20** | **12** | **10** | **22** |

**Minor Courses for other Discipline**

SUB/Mn/T/ 300 : This is a 2 credit theory course to be designed for other discipline

SUB/DSE/T/301: This is a 2 credit theory course to be designed for other discipline

**Structure of B. Sc. (Three / Four Years Honours / Honours with Research Degree) Programme with Multiple Entry and Exit Options**
**Subject (Major): Fishery Science**
**B.Sc. Third Year: VI$^{th}$ Semester**

| Course Type | Course Code | Examination Code (To be given by Respective BoS) | Course Name | Teaching Scheme ( Hrs / Week) | | Credits Assigned | | Total Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory | Practical | Theory | Practical | |
| Major (Core) Mandatory DSC | SUB/DSC/T/350 | SAC03113506T | Fish Biology | 2 | | 2 | | 2+2+2+2+2 =10 |
| | SUB/DSC/T/351 | SAC03113516T | Fish Economics | 2 | | 2 | | |
| | SUB/DSC/P/376 | SAC03113766P | Practical based on SUB/DSC/T/350 | | 4 | | 2 | |
| | SUB/DSC/P/377 | SAC03113776P | Practical based on SUB/DSC/T/351 | | 4 | | 2 | |
| | SUB/DSC/T/352 | | IKS-2 ( Indian Knowledge System related to Major) | 2 | | 2 | | |
| Discipline Specific Electives ( DSE) (Choose anyone from SUB/DSE/T/350and SUB/DSE/T/351 ) and corresponding Practicals | SUB/DSE/T/350 | | Ecology and Resource Management | 2 | | 2 | | 2+2=4 |
| | SUB/DSE/T/351 | | Engineering and Post-Harvest Technology | 2 | | 2 | | |
| | SUB/DSE/P/376 | | Practical based on SUB/DSE/T/350 | | 4 | | 2 | |
| | SUB/DSE/P/377 | | Practical based on SUB/DSE/T/351 | | 4 | | 2 | |
| Minor(Choose any one from pool of courses) **It is from different discipline of the same faculty** | SUB/Mn/T/350 | | Advanced Multi-Trophic and Circular Ecosystem | 2 | | 2 | | 2+2=04 |
| | SUB/Mn/T/351 | | Socio-Economics and Rural Live hoods | 2 | | 2 | | |
| OJT/ FP/CEP/CC/RP (Choose anyone from pool of courses) | SUB/OJT/P/376 | | Fishery Economics and Extension | | 8 | | 4 | 04 |
| | | | | **12** | **20** | **12** | **10** | **22** |
| **Exit option: Award of UG degree in Major with 132 credits OR continue with Major and Minor** | | | | | | | | |

## Minor Courses for other Discipline

SUB/Mn/T/ 350: This is a 2 credit theory course to be designed for other discipline
SUB/Mn/T/ 351: This is a 2 credit theory course to be designed for other discipline

**Detailed Illustration of Courses included in 5th and 6thsemester:**

**1) Major ( Core) subject are mandatory.**

SUB/DSC/T/300 : This is a 2 credit theory course corresponding to Major ( core) subject
SUB/DSC/T/301 : This is a 2 credit theory course corresponding to Major ( core) subject
SUB/DSC/P/326 : This is a 2 credit practical course based on SUB/DSC/T/300
SUB/DSC/P/327 : This is a 2 credit practical course based on SUB/DSC/T/301

SUB/DSC/T/350 : This is a 2 credit theory course corresponding to Major ( core) subject
SUB/DSC/T/351 : This is a 2 credit theory course corresponding to Major ( core) subject
SUB/DSC/P/376 : This is a 2 credit practical course based on SUB/DSC/T/350
SUB/DSC/P/377 : This is a 2 credit practical course based on SUB/DSC/T/351
SUB/DSC/T/302+ 352 (IKS-2) : This is a 2 credit theory course corresponding to Indian Knowledge System related to Major

2) **Discipline Specific Electives (DSE) :** (Needs to be chosen any one from pool of courses available at respective college). **These courses should be chosen related to Major.**

SUB/DSE/T/300 : This is a 2 credit discipline specific course ( elective) related to Major
SUB/DSE/T/301 : This is a 2 credit discipline specific course ( elective) related to Major
SUB/DSE/P/326 : This is a 2 credit practical course based on SUB/DSE/T/300
SUB/DSE/P/327 : This is a 2 credit practical course based on SUB/DSE/T/301

SUB/DSE/T/350 : This is a 2 credit discipline specific course ( elective) related to Major
SUB/DSE/T/351 : This is a 2 credit discipline specific course ( elective) related to Major
SUB/DSE/P/376 : This is a 2 credit practical course based on SUB/DSE/T/350
SUB/DSE/P/377 : This is a 2 credit practical course based on SUB/DSE/T/351

3) **Minor : It is from different discipline of the same faculty**

SUB/Mn/T/300 : This is a 2 credit theory from different discipline of the same faculty
SUB/Mn/T/301 : This is a 2 credit theory from different discipline of the same faculty

SUB/Mn/T/350 : This is a 2 credit theory from different discipline of the same faculty
SUB/Mn/T/351 : This is a 2 credit theory from different discipline of the same faculty

1) **VSC (Vocational Skill Courses)** : Choose any one from pool of courses. These courses should be based on Hands on Training corresponding to Major (core) subject.

SUB/VSC/T/300 : This is a 1 credit theory course based Hands on Training corresponding to Major ( core) subject.
SUB/VSC/T/301 : This is a 1 credit theory course based Hands on Training corresponding to Major ( core) subject.
SUB/VSC/P/326: This is a 1 credit practical course based on **SUB/VSC/T/300**
SUB/VSC/P/327: This is a 1 credit practical course based on **SUB/VSC/T/301**

2) **SUB/FP/CEP/P/326** : Field Project / Community engagement and service : This is a 2 credit practical course related to Field Project / community engagement and service

3) **SUB/OJT/P/376 :** This is a 4 credit practical course related to On job Training

**Programme Educational Objectives (PEOs) :**

Programme Educational Objectives (PEOs) for the Bachelor of Science Curriculum under the National Education Policy 2020:

1. **Mastery of Discipline-Specific Knowledge:** Graduates of the Bachelor of Science program will demonstrate a deep understanding of fundamental principles, theories, and methodologies in their chosen scientific discipline, enabling them to analyze complex problems, propose innovative solutions, and contribute to advancements in their field.

2. **Interdisciplinary Proficiency**: Graduates will possess the ability to integrate knowledge and skills from multiple scientific disciplines, fostering a holistic approach to problem solving and innovation. They will be equipped to address multifaceted challenges by drawing upon diverse perspectives and methodologies.

3. **Critical Thinking and Analytical Skills:** Graduates will develop strong critical thinking abilities, enabling them to evaluate information rigorously, analyze data effectively, and make informed decisions based on evidence. They will demonstrate proficiency in applying logical reasoning and scientific methods to solve problems and generate new knowledge.

4. **Leadership and Innovation:** Graduates will demonstrate leadership qualities and entrepreneurial mindset, capable of initiating and driving positive change in their organizations and communities. They will exhibit creativity, resilience, and adaptability, harnessing innovation to address complex challenges and seize opportunities for growth and advancement.

5. **Global Citizenship and Cultural Sensitivity:** Graduates will possess a global perspective and cultural sensitivity, recognizing the interconnectedness of diverse communities and the importance of collaboration across borders. They will engage in cross-cultural dialogue, embrace diversity, and contribute to the advancement of knowledge and understanding on a global scale.

These Programme Educational Objectives serve as guiding principles for the Bachelor of Science curriculum, reflecting our commitment to nurturing well-rounded graduates who are prepared to excel in their careers, contribute to society, and lead meaningful lives in a rapidly changing world.

**Programme Outcomes (POs):**

The National Education Policy (NEP) 2020 for India emphasizes several key aspects for Bachelor of Science (B.Sc.) programs, aiming to produce graduates who are not only well versed in their respective disciplines but also equipped with skills necessary for holistic development and employability. While specific program outcomes may vary between institutions and disciplines within B.Sc. programs, here are some common outcomes aligned with NEP 2020:

- **PO1.The citizenship and society:** Apply broad understanding of ethical and professional skill in science subjects in the context of global, economic, environmental and societal realities while encompassing relevant contemporary issues.

- **PO2.Environment and sustainability**: Apply broad understanding of impact of science subjects in a global, economic, environmental and societal context and demonstrate the knowledge of, and need for sustainable development.

- **PO3.Ethics:** Apply ability to develop sustainable practical solutions for science subject related problems within positive professional and ethical boundaries.

- **PO4.Individual and team work:** Function effectively as a leader and as well as team member in diverse/ multidisciplinary environments.

- **PO5.Communication**: Communicate effectively on complex science subject related activities with the scientific community in particular and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

- **PO6.Project management and finance:** Demonstrate knowledge and understanding of the first principles of science and apply these to one's own work as a member and leader in a team, to complete project in any environment.

- **PO7.Life-long learning:** Recognize the need for lifelong learning and have the ability to engage in independent and life-long learning in the broadest context of technological change.

These program outcomes align with the broader goals of NEP 2020 to transform higher education in India and prepare students for the challenges and opportunities of the 21st century. Board of Studies designing B.Sc. curricula are encouraged to incorporate these outcomes into their program objectives and learning outcomes.

**Programme Specific Outcomes (PSOs):**

(Programme specific outcomes are discipline / major specific. Different major will have different PSOs. Following is the example of PSOs for Electronics Major. Respective BoS is expected to draft PSOs related to their Major)

- **PSO1. Domain knowledge:** Apply the knowledge of electronics fundamental and advanced areas of Electronics to provide comprehensive solution of problems in complex electronics.

- **PSO2. Problem Analysis:** Identify electronics related problems at varied complexity and analyze the same to formulate/ develop substantiated conclusion using first principles of Electronics

- **PSO3. Design Development of solutions:** Design/ develop solutions for problems at varied complexity in various areas of Electronics to address changing challenges put forward by market demand/ stakeholder

- **PSO4. Conduct Investigation of complex problems:** Use established knowledge and methods to design of experiments, analyze resulting data and interpret the same to provide valid conclusions.

- **PSO5. Modern tools:** Create, select, and apply appropriate techniques, resources, and modern electronics and relevant IT tools including prediction and modelling to complex electronics technology related activities with clear understanding of the limitations.

# B.Sc.

# Fishery Science

# Third Year

# (Semester V$^{th}$)

**SUB/DSC/T/300 : MODERN TRENDS IN FISHERY SCIENCE-I**

Total Credits : 02

Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To introduce students to advanced aquaculture systems such as Recirculatory Aquaculture Systems (RAS), Biofloc technology, and Cage Culture.
- To familiarize learners with the role of Information Technology (IT), Remote Sensing (GIS), and Artificial Intelligence (AI) in monitoring fish stocks and water quality.
- To instill a deep understanding of responsible fishing practices and the conservation of endangered aquatic biodiversity.
- To provide a basic understanding of the seafood supply chain, value addition, and the potential for "Blue Startups."
- To study the impact of global warming and ocean acidification on fisheries and explore adaptive mitigation strategies.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Identify and explain the mechanics of modern intensive farming techniques versus traditional extensive methods.
- Use basic software or data tools for water quality assessment and biomass estimation.
- Critically analyze the status of Indian and global fisheries and suggest methods for sustainable yield.
- Understand the principles of fish preservation, quality control (HACCP), and the creation of value-added products (like fish wafers or pickles).
- Discuss the legal frameworks (like the Maritime Zones Act) and ethical considerations in aquatic animal welfare and community rights.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | **Advanced Aquaculture Systems:**<br>• Recirculating Aquaculture Systems (RAS): Principles, design, and bio-filtration.<br>• Biofloc Technology (BFT): Carbon-Nitrogen ratio (C:N), microbial floc formation, and its role in zero-water exchange systems.<br>• Integrated Multi-Trophic Aquaculture (IMTA): Combining fed species (finfish) with extractive species (seaweeds and shellfish). | **10Hrs** |

| | | |
|---|---|---|
| **II** | **Digitalization & Precision Fisheries:**<br>• Remote Sensing & GIS: Mapping Potential Fishing Zones (PFZ) and habitat modeling.<br>• Artificial Intelligence (AI) and IoT: Using sensors for real-time water quality monitoring (pH, DO, Temperature) and automated feeding systems.<br>• Hydro acoustics: Use of Echo-sounders and Sonar for biomass estimation and behaviour study.<br>• Ecosystem-Based Fisheries Management (EBFM): Moving beyond single-species management. | **10 Hrs** |
| **III** | **Modern Post-Harvest Technology:**<br>• Value Addition: Production of Surimi, fish protein concentrates, and bioactive peptides.<br>• Smart Packaging: Modified Atmosphere Packaging (MAP) and active packaging.<br>• Waste Utilization: Converting fish waste into fish silage, chitin, and collagen. | **10 Hrs** |

## Recommended Textbooks


1. Pandian, T. J. (2021). *Modern Trends in Fish Biology*. CRC Press.
2. Avnimelech, Y. (2015). *Biofloc Technology: A Practical Guide Book*. World Aquaculture Society.
3. Lekang, O. I. (2013). *Aquaculture Engineering*. Wiley-Blackwell.
4. Nagabhushanam, R., & Thompson, M. F. (2005). *Trends in Biotechnology*. Oxford & IBH Publishing.
5. FAO Fisheries Technical Paper No. 589. *The State of World Fisheries and Aquaculture (SOFIA)*. (Essential for current global trends).
6. Dunham, R. A. (2011). *Aquaculture and Fisheries Biotechnology: Genetic Approaches*. CABI Publishing.
7. Sahu, B. B. (2018). *Nanotechnology in Fisheries and Aquaculture*. Narendra Publishing House.
8. Fish statistics & Modern Trends in Fishery Science by Dr. S L Bhalkare , Laxmi book publication, Pune

## SUB/DSC/T/301 : FISH TECHNOLOGY AND PROCESSING

Total Credits : 02

Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To provide in-depth knowledge of the biochemical, microbiological, and physical changes that occur in fish post-mortem.
- To train students in various preservation methods, including chilling, freezing, canning, drying, salting, and smoking.
- To encourage the development of "value-added" products such as fish pickles, wafers, surimi (fish paste), and fish oil to increase profitability.
- To teach efficient utilization of fishery by-products (e.g., chitin, chitosan, and fish meal) to ensure a "zero-waste" industry.
- To familiarize students with international food safety standards, including **HACCP** (Hazard Analysis and Critical Control Points) and **ISO** certifications.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Identify and explain the mechanics of modern intensive farming techniques versus competently use sensory, chemical, and microbiological methods to determine the quality and shelf-life of various fish and shellfish species.
- Demonstrate hands-on skills in operating cold storage systems, IQF (Individual Quick Freezing) units, and canning retorts.
- Formulate and prepare diverse fish products and by-products, fostering an entrepreneurial mindset for the "Blue Economy."
- Design and audit a basic HACCP plan for a fish processing unit, ensuring compliance with global export regulations (like USFDA or EU norms).
- Understand and explain the nutritional value of fish (Omega-3 fatty acids, high-quality proteins) and how processing affects these nutrients.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | **Biochemistry of Fish and Post-Harvest Handling:**<br>• Composition of Fish: Proximate composition (proteins, lipids, moisture, ash) and nutritional significance.<br>• Post-Mortem Changes: The Rigor Mortis cycle Pre-rigor, Rigor, and Post-rigor; autolysis and microbial spoilage.<br>• Handling of Fresh Fish: Principles of handling fish on board and at landing centers; use of crushed ice and refrigerated seawater (RSW).<br>• Chilling: Methods of icing and the shelf-life of chilled fish. | **10 Hrs** |

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| | • Freezing Principles: Crystallization, quick vs. slow freezing, and the "Critical Zone" (0°C to -5°C).<br>• Freezing Equipment: Air blast freezers, contact plate freezers, and Individually Quick Frozen (IQF) systems. | |
| II | **Thermal Processing and Traditional Preservation:**<br>• Principles of Canning: The "Botulinum Cook," heat penetration, and thermal death time (TDT).<br>• Canning Process: Cleaning, blanching, filling, exhausting, double-seaming, retorting, and cooling.<br>• Curing: Drying (solar and mechanical), salting (dry, wet, and pit curing), and smoking (cold and hot smoke).<br>**Value Addition and By-Products:**<br>• Value-Added Products: Production of Surimi (minced fish paste), fish fingers, wafers, and breaded/battered products.<br>• Industrial By-products: Extraction of fish oil, fish meal production, fish silage, and shark liver oil.<br>• Biomaterials: Extraction of Chitin and Chitosan from shellfish waste; fish collagen. | **10 Hrs** |
| III | **Quality Assurance and Regulatory Standards:**<br>• Assessment Tools: Sensory (organoleptic) evaluation; chemical indices (TVB-N, TMA, Peroxide value).<br>• Safety Management: Principles of HACCP (Hazard Analysis and Critical Control Points) and SSOP (Sanitation Standard Operating Procedures).<br>• National/International Standards: Role of FSSAI, MPEDA, Codex Alimentarius, and FDA. | **10 Hrs** |

## Suggested References


1. Hall, G. M. (1997). *Fish Processing Technology*. Blackie Academic & Professional, London.
2. Balachandran, K. K. (2001). *Post-harvest Technology of Fish and Fish Products*. Daya Publishing House, Delhi.
3. Huss, H. H. (1995). *Quality and Quality Changes in Fresh Fish*. FAO Fisheries Technical Paper No. 348.
4. Govindan, T. K. (1985). *Fish Processing Technology*. Oxford & IBH Publishing Co.

**SUB/DSC/P/ 326: MODERN TRENDS IN FISHERY SCIENCE-I**

Total Credits : 02

Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- Provide hands-on experience with modern aquaculture systems like Biofloc, RAS, and Aquaponics.
- Teach the use of advanced digital sensors and kits to monitor the "health" of the aquatic environment.
- Familiarize students with the use of GPS, Echo-sounders, and remote sensing software for locating fish stocks.
- Train students in non-invasive methods of fish health monitoring and the application of probiotics/immunostimulants.
- Connect students with local fish farms and hatcheries to understand the socio-economic and operational realities of modern fisheries.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Setup and maintain a basic Biofloc unit or a small-scale Recirculatory Aquaculture System (RAS), including the management of "beneficial bacteria" (C/N ratio).
- Independently perform water and soil analysis using both titration methods and digital multi-parameter probes (pH, Dissolved Oxygen, Ammonia, Nitrates).
- Read and interpret satellite-based Potential Fishing Zone (PFZ) maps and operate handheld GPS devices for field data collection.
- Use mathematical models and sampling techniques to estimate fish population, growth rates (SGR), and Feed Conversion Ratios (FCR) in a farm setting.
- Prepare professional field reports and case studies based on visits to advanced fish processing units or high-tech farms.

| Module | Topics / actual contents of the syllabus | Contact Hours |
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| I | • Design and Setup of a Biofloc Unit: Calculation of C: N ratio based on feed protein content; preparation of inoculums (Carbon source + Probiotics).<br>• Water Quality Monitoring: Comparison of traditional titration methods vs. digital multi-parameter probes for: Dissolved Oxygen (DO), Ammonia ($NH_3$), Nitrite ($NO_2$), pH, Alkalinity, Turbidity etc. | **10Hrs** |

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| **II** | • DNA Extraction: Basic isolation of genomic DNA from fish tissue (fin clips or scales).<br>• Visualization of DNA using Agarose Gel Electrophoresis.<br>• Cryopreservation Protocols: Preparation of extenders and cryoprotectants; demonstration of the cooling and thawing process for fish milt.<br>• Remote Sensing Data Interpretation: Analyzing Sea Surface Temperature (SST) and Chlorophyll-amaps to identify Potential Fishing Zones (PFZ). | **10 Hrs** |
| **III** | • Value-Added Product Development: Preparation of fish silage from processing waste using organic acids.<br>• Quality Assessment: Organoleptic (sensory) evaluation and Total Volatile Base Nitrogen (TVB-N) analysis of fresh vs. chilled fish.<br>• Smart Packaging: Demonstration of vacuum packaging or Modified Atmosphere Packaging (MAP) impacts on shelf life.<br>**Filed Visit**: Prepare professional field reports and case studies based on visits to advanced fish processing units or high-tech farms. | **10 Hrs** |

## Recommended Textbooks


1. Avault, J. W. (1996). Fundamentals of Aquaculture. AVA Publishing Company. (Great for system design).
2. Pandian, T. J. (2001). Sustainable Fisheries Management. CRC Press.
3. Lakshmanan, P. T., et al. (2015). Post-harvest Technology of Fish and Fish Products. ICAR-CIFT.
4. FAO Fisheries Technical Paper No. 428. Farming Freshwater Prawns: A Manual for the Culture of the Giant River Prawn.
5. Rakocy, J. E. (2012). Recirculating Aquaculture Tank Production Systems. SRAC Publication No. 454.
6. Avnimelech, Y. (2012). Biofloc Technology - A Practical Guide Book. World Aquaculture Society.

**SUB/DSC/P/327: FISH TECHNOLOGY AND PROCESSING**

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- Train students to evaluate fish freshness using sensory (organoleptic), chemical, and microbiological indicators.
- Provide direct experience in various preservation methods such as freezing, salting, drying, and smoking.
- Teach the formulation and preparation of value-added products and by-products to enhance profitability.
- Familiarize students with the practical application of hygiene protocols and **HACCP** (Hazard Analysis and Critical Control Points) in a processing environment.
- Study the role of different packaging materials and techniques (like vacuum packaging) in extending the shelf life of seafood.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Identify the stages of fish spoilage (Rigor Mortis to Autolysis) and determine the suitability of raw material for processing.
- Operate standard processing equipment, including blast freezers, solar driers, and canning retorts.
- Prepare high-quality value-added items (e.g., fish balls, fingers, pickles) and industrial by-products (e.g., fish meal, silage, or chitin).
- Conduct basic tests for Total Plate Count (TPC) and identify common pathogens to ensure food safety.
- Draft a basic technical flow chart for a processing line, identifying critical control points to prevent contamination.
- Students will be ready to work as junior QC laboratory technicians.
- Graduates can manage small-scale processing units or cold storage facilities.
- The skills acquired allow students to start their own "Blue Startup" focused on ready-to-eat seafood.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | **Freshness Evaluation & Handling:**<br>• Organoleptic (Sensory) Evaluation: Assessment of fish freshness using the Quality Index Method (QIM). Evaluation of eyes, gills, skin texture, and odor.<br>• Icing Techniques: Practical demonstration of different icing ratios (1:1, 1:2) and layers. Calculating the melting rate of ice in different insulation boxes.<br>• Determination of Dressing Percentage: Calculating the yield of fillets, steaks, and headed/gutted fish compared to whole body weight. | **10 Hrs** |

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| | • Chemical Indices of Spoilage: Estimation of Total Volatile Base Nitrogen (TVB-N) and Trimethylamine (TMA-N).<br>• Microbiological Analysis: Preparation of media and determination of Total Plate Count (TPC) in fresh vs. spoiled fish samples.<br>• pH Measurement: Monitoring the post-mortem pH shift in fish muscle. | |
| **II** | **Preservation & Processing Techniques**<br>• Curing & Drying: Preparation of salted fish (Dry vs. Wet salting).<br>• Determination of moisture content in sun-dried and mechanically dried fish products.<br>• Canning Lab: Evaluation of Double Seam parameters in tin cans (Overlap, Body Hook, Cover Hook).<br>• Preparation of Value-Added Products: Fish pickles, fish wafers (crackers), and breaded/battered products (fish fingers). | **10 Hrs** |
| **III** | • Chlorine Demand Estimation: Calculating the amount of chlorine required for process water and plant sanitation.<br><br>**Filed Visit:** Students visits to fish Packaging Industry/ processing unit nearby places and prepared details reports and submitted to Department at the time of practical examination | **10 Hrs** |

**Recommended Textbooks**


1. Gopakumar, K. (2002). *Textbook of Fish Processing Technology*. ICAR, New Delhi.
2. Balachandran, K. K. (2001). *Post-harvest Technology of Fish and Fish Products*. Daya Publishing House.
3. Lars Herborg (1991). *Manual on Fish Canning*. FAO Fisheries Technical Paper.
4. CIFT Manuals. *Methods of Analysis for Fish and Fishery Products*. Central Institute of Fisheries Technology, Kochi.
5. Hall, G. M. (1997). *Fish Processing Technology*. Blackie Academic & Professional.
6. Sen, D. P. (2005). *Advances in Fish Processing Technology*. Allied Publishers.

**SUB/DSC/T/302 : IKS- 1 INDIAN KNOWLEDGE SYSTEM RELATED TO MAJOR**

Total Credits : 02

Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To trace the evolution of ichthyology (study of fish) in India, from ancient texts like the *Manasollasa* and *Arthaśāstra* to colonial-era records.
- To scientifically analyze indigenous practices in fish breeding, pond management, and habitat conservation.
- To explore the engineering principles behind indigenous fishing gears (nets, traps, and rafts) and their modern counterparts.
- To document and understand ancient methods of fish preservation (natural drying, fermentation) that align with modern "green" technology.
- To study traditional community-based fishery management and its relevance to India's current Blue Economy policies and sustainable development goals.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Critically discuss the contribution of ancient Indian scholars to the classification and biology of fishes.
- Apply traditional concepts of aquatic ecology and "Vrikshayurveda" (in the context of pond bank vegetation) to modern aquaculture farm management.
- Contrast the selectivity and sustainability of indigenous fishing gear with modern mechanized methods, advocating for "low-impact" fishing.
- Demonstrate knowledge of ethnic fish processing methods (e.g., *Shidal*, *Hentak*) and their nutritional/microbiological benefits.
- Draft suggestions for fishery policies that respect traditional "Common Property Resource" (CPR) rights while promoting modern economic growth.
- Exhibit a sense of pride in Indian scientific heritage while maintaining a rigorous, evidence-based scientific temper.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | **Evolution of Ichthyological Knowledge in India:**<br>• A comparative study of ancient Indian fish classification (based on *Guna* and *Rasa*).<br>• Ethno-Ichthyology: Integration of traditional ecological knowledge (TEK) from indigenous fishing communities.<br>• Historical Biogeography: Ancient Indian understanding of fish distribution and its relevance to modern climate change studies and migration tracking.<br>• Fish Health Managements ( Herbal). | **10 Hrs** |

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| **II** | **Modern Harvest Technologies & Indigenous Gear:**<br>• Smart Fishing: Enhancing traditional gear (*Polo, Vellavali*).<br>• Selective Harvesting: Applying ancient concepts of "Dharma" (ethics) in fishing to modern Minimum Legal Size (MLS) regulations and By-catch Reduction Devices (BRDs).<br>• Green Preservation: Modern scientific validation of traditional preservation methods (using salt, turmeric, and smoke) as "Clean Label" alternatives to chemical preservatives. | **10 Hrs** |
| **III** | **Fish Economy, Policy, and the Blue Economy:**<br>• From Arthashastra to PMMSY: A comparative analysis of Kautilya's economic policies on fisheries versus the Pradhan Mantri Matsya Sampada Yojana (PMMSY). | **10 Hrs** |

## Recommended Textbooks and References


1. Sadhale, N. (2012). *Manasollasa (Book 3 - Vimsati 4): Fish and Fishing*. Asian Agri-History Foundation. (Essential for the historical foundation).
2. Gopakumar, K. (2002). *Textbook of Fish Processing Technology*. ICAR, New Delhi. (For modern processing techniques).
3. Srivastava, P. K. (1991). *Fishery Development in India*. Deep & Deep Publications.
4. Biju Kumar, A., et al. (2021). *Biodiversity and Management of Aquatic Resources*. (Links TEK with modern management).
5. Vikas, P. A., et al. (2018). *Traditional Knowledge in Fisheries*. CMFRI Special Publication.
6. FAO. *Code of Conduct for Responsible Fisheries*. (To compare with ancient ethical fishing).
7. Hall, G. M. (1997). *Fish Processing Technology*. Blackie Academic & Professional.
8. Ministry of Fisheries, GoI. *PMMSY Operational Guidelines*. (For modern policy study).

**SUB/DSC/P/302 : IKS- 1 INDIAN KNOWLEDGE SYSTEM RELATED TO MAJOR**

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To record traditional nomenclature and classification of local fish species used by indigenous communities.
- To study the design, material science, and selectivity of indigenous fishing traps and nets (e.g., bamboo traps, eco-friendly nets).
- To test the efficacy of ancient methods, such as using medicinal plants for water purification or fish health.
- To gain hands-on experience in traditional fish processing techniques like fermentation and sun-drying.
- To understand the socio-economic structure of traditional fishing villages and their role in the modern "Blue Economy."

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Conduct field interviews and surveys to document traditional ecological knowledge (TEK) from local fishing communities.
- Identify the engineering principles of traditional gear and evaluate their environmental impact compared to modern industrial gear.
- Demonstrate the use of traditional herbs (like Neem, Turmeric, or Garlic) in managing basic fish pond health.
- Prepare traditional Indian fish products (such as dried fish or fermented pastes) and evaluate their shelf life and nutritional value.
- Evaluate the "Fishery Value Chain" in local markets, identifying how traditional fishers interact with the modern economy.
- Students learn to treat traditional wisdom as a hypothesis that can be tested with modern scientific tools.
- By understanding indigenous gear, students can advocate for "Sustainable Harvest Technologies" that prevent overfishing.
- Graduates will be better equipped to work in extension services, respecting and integrating local community practices into government policies.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | • Documentation of local fish fauna using traditional nomenclature. Compare local names with scientific names and identify descriptions that match ancient texts (e.g., *Manasollasa*).<br>• Qualitative analysis of fish "quality" based on traditional sensory markers (gills, scales, and slime) as described in indigenous wisdom. | **10 Hrs** |

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| **II** | • Laboratory trial on the antimicrobial properties of IKS-based additives (e.g., Turmeric, Neem, or Tulsi) in controlling common fish skin pathogens.<br>• Comparative sensory evaluation (Taste, Texture, Aroma) between traditionally smoked fish and modern oven-dried fish | **10 Hrs** |
| **III** | **Field Visit :**<br>• To observe the operation of indigenous gear (like the *Kattumaram* or cast nets) in real-time: Interviewing elder fishers to document "Lunar Calendars"-how they use moon phases and tides to predict fish movement.<br>• To study the traditional fish economy and value chain: Mapping the "Fisher-to-Consumer" route and understanding the role of women (*Fisherwomen*) in traditional processing and micro-economy management. | **10 Hrs** |

**Recommended Textbooks**


1. Sadhale, N. (2012). *Manasollasa (Book 3 - Vimsati 4): Fish and Fishing*. Asian Agri-History Foundation. (Essential for the historical foundation).
2. Gopakumar, K. (2002). *Textbook of Fish Processing Technology*. ICAR, New Delhi. (For modern processing techniques).
3. Biju Kumar, A., et al. (2021). *Biodiversity and Management of Aquatic Resources*. (Links TEK with modern management).
4. Vikas, P. A., et al. (2018). *Traditional Knowledge in Fisheries*. CMFRI Special Publication.
5. FAO. *Code of Conduct for Responsible Fisheries*. (To compare with ancient ethical fishing).
6. Hall, G. M. (1997). *Fish Processing Technology*. Blackie Academic & Professional.
7. Ministry of Fisheries, GoI. *PMMSY Operational Guidelines*. (For modern policy study).

## SUB/DSE/T/300: ORNAMENTAL FISH PRODUCTION

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To familiarize students with the biology, habitat, and breeding habits of popular freshwater and marine ornamental fishes.
- To provide expertise in the captive breeding of egg-layers (like Goldfish and Tetras) and live-bearers (like Guppies and Mollies).
- To teach the design, construction, and maintenance of various types of aquaria, including planted (high-tech) and marine reef systems.
- To understand the specific dietary requirements (live vs. formulated feed) and common diseases associated with aquarium fishes.
- To provide insight into the global export-import market, packaging for long-distance transport, and the "Blue Startup" potential in the hobbyist sector.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Accurately identify major ornamental species and varieties, and suggest compatible "community tank" combinations.
- Independently manage a small-scale breeding facility, including the preparation of spawning mops, hormone injection (if required), and larval rearing.
- Construct and set up aquaria with appropriate filtration (mechanical, chemical, and biological), lighting, and aeration systems.
- Prepare high-quality larval feeds (like Infusoria or Artemia) and color-enhancing formulated diets.
- Demonstrate the "conditioning" and "oxygen-packing" techniques required for the safe transport of live fish to national and international markets.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | **Introduction to Aquarium Hobby:**<br>• Overview: Global and National status of the ornamental fish industry; Importance of the hobby as a source of livelihood.<br>• Classification: Popular freshwater and marine ornamental fishes (Indigenous vs. Exotic).<br>• Biology of Popular Species: Guppies, Goldfish, Angelfish, Tetras, Barbs, Cichlids, and Koi.<br>**Aquarium Design and Construction:**<br>• Tank Construction: Selection of glass/acrylic, cutting, and sealing; Design of all-glass tanks and community tanks.<br>• Support Systems: Filters (Under-gravel, Power, Canister, Sponge); Aerators; Heaters and Thermostats.<br>• Lighting: Types of aquarium lights and their role in | **10 Hrs** |

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| | plant growth and fish coloration.<br>• Aquascaping: aquatic plants. | |
| II | **Breeding and Seed Production:**<br>• Induced Breeding: Use of synthetic hormones (Ovaprim/ Ovatide) in ornamental fish.<br>• Common Diseases: Diagnosis and treatment of White Spot (Ich), Fin rot, Dropsy, and Velvet disease.<br>• Nutrition: Formulated feeds (pellets, flakes.<br>• Water Quality: Maintaining optimal pH, Hardness, Ammonia, and Dissolved Oxygen levels. | **10 Hrs** |
| III | **Marketing and Transportation:**<br>• Packaging: Closed and Open systems; Use of oxygen, anesthetics, and anti-microbials during transport.<br>• Marketing: Export-import regulations; Role of MPEDA (Marine Products Export Development Authority) in ornamental fish trade.<br>• Green Certification: Introduction to eco-labeling and sustainable collection from the wild. | **10 Hrs** |

## Recommended Textbooks and References


1. Dey, V. K. (1997). *Hand Book on Aquascaping*. MPEDA, Cochin.
2. Swain, S. K. et al. (2010). *Ornamental Fish Farming*. Central Institute of Freshwater Aquaculture (CIFA).
3. Ramachandran, A. (2002). *Breed and Raise Your Own Aquarium Fishes*. Daya Publishing House.
4. Jameson, J. D. and Santhanam, R. (1996). *Manual of Ornamental Fishes*. Gujarat Agricultural University.
5. Axelrod, H. R. (1995). *Encyclopedia of Tropical Fishes*. T.F.H. Publications.
6. Mills, D. (1993). *Aquarium Fish*. Eyewitness Handbooks.
7. Saksena, D. N. (2003). *Ornamental Fish Culture and Aquarium Management*. ADH Publishing.
8. MPEDA. *Production and Export of Ornamental Fishes* (Technical Manual).

**SUB/DSE/T/301: FRESH WATER PRAWN CULTURE**

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To study the life cycle, reproductive biology, and nutritional requirements of commercially important freshwater prawns.
- To provide technical knowledge on larval rearing, including the management of "Green Water" or "Clear Water" systems and the transition from brackish to freshwater.
- To teach various culture systems, including monoculture, polyculture (with carps), and integrated farming (prawn-on-paddy).
- To understand the specific environmental parameters (like Calcium hardness and alkalinity) critical for the moulting process in prawns.
- To identify common bacterial, viral (e.g., White Tail Disease), and fungal infections and implement biosecurity measures.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Successfully operate a scampi hatchery, including broodstock maintenance, larval feeding schedules, and post-larvae (PL) production.
- Design and construct prawn ponds with appropriate bottom topography, aeration systems, and peripheral trenches.
- Formulate and manage feeding regimes using high-protein pellets, accounting for the benthic (bottom-dwelling) feeding habits of prawns.
- Monitor and manage the "Moulting Cycle," ensuring appropriate water chemistry to minimize cannibalism during the soft-shell phase.
- Evaluate the cost-benefit ratio of scampi farming and understand the cold chain requirements for domestic and export markets.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | **Biology and Taxonomy of Prawns**<br>• Systematic Position: Classification of commercially important freshwater prawns (*Macrobrachium* species).<br>• Morphology and Biology: External anatomy of *M. rosenbergii*; food and feeding habits; molting and growth; life cycle (Egg-Larva-Post Larva-Juvenile-Adult).<br>• Distribution: Global and national distribution of prawn resources in India.<br>**Hatchery Management and Seed Production**<br>• Site Selection: Criteria for setting up a prawn hatchery (inland vs. coastal sites).<br>• Brood stock Management: Collection, transportation, and maintenance of spawners; water quality | **10 Hrs** |

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| | requirements for berried females.<br>• Larval Rearing: Larval stages (11 stages); feeding regimes (Artemia, egg custard); green water vs. clear water systems.<br>• Water Quality in Hatchery: Salinity requirements (12 ppt), pH, temperature, and ammonia management. | |
| II | **Grow-out Farming Systems**<br>• Pond Construction: Site selection, soil quality, and design of prawn ponds.<br>• Seed Selection and Acclimatization: Nursery rearing of Post-Larva (PL); methods of stocking and acclimatization to freshwater.<br>• Monoculture vs. Polyculture: advantages and disadvantages.<br><br>**Nutrition and Health Management**<br>• Feeding: Nutritional requirements of prawns; natural food vs. artificial pellet feeds; feed conversion ratio (FCR).<br>• Disease Management: Common bacterial (Vibriosis), viral (White Tail Disease - WTD), and fungal diseases; prophylaxis and treatment. | **10 Hrs** |
| III | **Harvesting, Processing, and Economics**<br>• Harvesting: Methods of harvesting (drain harvesting vs. cull harvesting); blue-clawed vs. orange-clawed males.<br>• Post-harvest Handling: Washing, chilling, and icing; export standards for prawn tails.<br>• Economics: Cost-benefit analysis of a 1-hectare prawn farm; market potential for Scampi. | **10 Hrs** |

**Recommended Textbooks and References**


1. Dongre S.B, Chinte D.N, Wagh D C and Shejwal P M (2026) Text Book of Freshwater Prawan Cullture, Eductional Publishing ,Chhatrapati Sambhajinagar(MS) India.
2. New, M. B. (2002). *Farming Freshwater Prawns: A Manual for the Culture of the Giant River Prawn (Macrobrachium rosenbergii)*. FAO Fisheries Technical Paper No. 428.
3. Sakhare V. B(2012) Inland Fisheries ,Daya Puplishing House,New Delhi.
4. Kurian, C. V. and Sebastian, V. O. (1993). *Prawns and Prawn Fisheries of India*. Hindustan Publishing Corporation.
5. Reddy, A. K. (2011). *Freshwater Prawn Farming*. ICAR-Central Institute of Fisheries Education (CIFE).
6. Jayachandran, K. V. (2001). *Palaemonid Prawns: Biodiversity, Taxonomy, Biology and Management*. Science Publishers.
7. New, M. B., & Valenti, W. C. (2000). *Freshwater Prawn Culture*. Blackwell Science, UK.
8. Adiyodi, K. G., & Adiyodi, R. G. *Reproductive Biology of Invertebrates*. John Wiley & Sons.
9. MPEDA. *Technical Manuals on Scampi Farming*. Marine Products Export Development Authority, India.

## SUB/DSE/P/ 326: ORNAMENTAL FISH PRODUCTION

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To provide hands-on training in aquarium fabrication, including glass cutting, silicon application, and leak testing.
- To demonstrate the specific environmental and hormonal triggers required to breed different varieties of live-bearers and egg-layers.
- To teach the culture and enrichment of microscopic live food (like *Artemia* and *Daphnia*) essential for larval survival.
- To introduce the principles of "Nature Aquarium" design, focusing on the balance between aquatic flora, substrate, and hardscapes.
- To master the maintenance of high-water quality in closed-loop systems and the identification of common aquarium pathogens.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Independently build and set up customized aquarium tanks of various sizes with integrated filtration systems.
- Successfully manage the breeding cycle of at least three different species (e.g., Guppies, Goldfish, and Betta), from pair selection to fry rearing.
- Set up and maintain "starter cultures" of various live food organisms to ensure a steady supply of nutrient-dense feed for fry.
- Perform "dip and bath" treatments for common diseases like Ich (White Spot) and Fin Rot, and calculate correct dosages for aquarium medication.
- Demonstrate professional "oxygen packing" techniques, ensuring zero mortality during simulated long-distance transport.
- Students can immediately start a small-scale home-based breeding or aquarium maintenance business.
- Graduates are prepared for roles as consultants or managers in high-end aquarium boutiques and galleries.
- Provides a foundation for advanced work in public aquaria or conservation-focused captive breeding programs.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | • Tank Construction: Hands-on glass cutting, edge grinding, and silicon bonding for all-glass aquaria.<br>• Filter Assembly: Setting up internal, external, and canister filters; preparation of filter media (activated carbon, ceramic rings, bio-balls).<br>• Water Quality Testing: Practical use of test kits to measure Carbonate Hardness (CH), General Hardness (GH), Ammonia, and Phosphates.<br>• Sex Identification: Morphological identification of male and female Guppies, Mollies, Swordtails, Goldfish, and Cichlids. | 10 Hrs |

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| | • Egg-layer Breeding: Goldfish: Natural and induced spawning (stripping technique).<br>➢ Anabantids: Inducing bubble-nest building in Fighting fish (Betta) or Gouramis. | |
| **II** | • Feed Formulation: Preparation of high-protein larval mash and color-enhancing flake feeds.<br>• Microscopic Examination: Identification of common parasites like ,<br>• *Ichthyophthirius* (White spot),<br>• *Dactylogyrus* (Gill fluke), and<br>• *Argulus* (Fish louse).<br>• Therapeutic Baths: Practical demonstration of Salt baths, Formalin dips, and Malachite Green treatments. | **10 Hrs** |
| **III** | • **Project Report:** Preparation of a techno-economic feasibility report for a small-scale ornamental fish breeding unit.<br>• **Conditioning for Transport**: Fasting, anesthesia (using clove oil), and oxygen packing for long-distance transport.<br>• **Market Survey**: Visit to a commercial ornamental fish farm or an aquarium export house. | **10 Hrs** |

**Recommended Practical Manuals & Textbooks**


1. Dey, V. K. (1997). *Hand Book on Aquascaping*. MPEDA, Cochin. (Excellent for fabrication and design).
2. Swain, S. K. et al. (2010). *Ornamental Fish Farming*. Central Institute of Freshwater Aquaculture (CIFA). (Best for breeding protocols).
3. Ahilan, B. et al. (2008). *Handbook on Ornamental Fishes*. Dayas Publishing House, Delhi.
4. Saksena, D. N. (2003). *Ornamental Fish Culture and Aquarium Management*. ADH Publishing.
5. Axelrod, H. R. (1995). *Encyclopedia of Tropical Fishes*. T.F.H. Publications.
6. Jhingran, V. G. (1991). *Fish and Fisheries of India*. Hindustan Publishing Corporation. (Section on Ornamental Fisheries).
7. ICAR-CIFA Manuals. *Breeding and Seed Production of Finfishes*.

**SUB/DSE/P/ 326: FRESH WATER PRAWN CULTURE**

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To train students in identifying different life stages of prawns, from Zoea (larvae) to Post-Larvae (PL) and adults.
- To provide experience in managing "Green Water" and "Clear Water" systems, and the precise salinity adjustments required during larval rearing.
- To teach the measurement of growth, survival rates, and the identification of the different male morphotypes (Blue Claw, Orange Claw, and Small Male).
- To master the testing of specific parameters like Calcium hardness, alkalinity, and dissolved oxygen that directly impact the prawn's moulting process.
- To provide training in selective harvesting (culling) and the proper post-harvest handling to maintain the quality of the delicate prawn meat.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Independently manage the incubation and hatching of berried (egg-carrying) females and rear larvae through their 11 distinct stages.
- Differentiate between species and sexes, and identify the moult stage of a prawn through microscopic or visual examination of the exoskeleton.
- Prepare and schedule larval feeds (such as egg custard and *Artemia* nauplii) and calculate feed requirements for grow-out ponds.
- Identify common clinical signs of disease, such as "Black Spot" or "White Tail," and apply preventative treatments.
- Draft a technical plan for a prawn farm, including peripheral trenches for shelter and aeration placement to prevent cannibalism.
- Students will be capable of working as technicians in commercial scampi hatcheries.
- Graduates will have the skills to manage high-value intensive prawn farms.
- The course provides the foundation for setting up small-scale "paddy-cum-prawn" integrated systems.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | • Identification: Morphological identification of commercially important freshwater prawns: *Macrobrachium rosenbergii*, *M. malcolmsonii*, and *M. idella*.<br>• Anatomy: Dissection to study the digestive system, nervous system, and reproductive system of the Giant Freshwater Prawn.<br>• Sexual Dimorphism: Identification of male and female prawns; differentiation of blue-clawed (BC), orange-clawed (OC), and small males (SM).<br>• Brood stock Selection: Identification of "berried" (egg-bearing) females; observing embryonic | **10 Hrs** |

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| | development (orange to grey egg color change).<br>• Larval Stage Identification: Microscopic observation and drawing of the 11 zoeal stages of *M. rosenbergii*.<br>• Larval Feeding: Preparation of egg-custard feed and cultivation of *Artemia* nauplii for larval feeding. | |
| **II** | • Water Analysis: Determination of Dissolved Oxygen (DO), Total Alkalinity, Total Hardness, and Ammonia (NH3-N) in prawn ponds.<br>• Soil Analysis: Estimation of soil pH<br>• Feeding Management: Calculating Daily Feed Allowance (DFA) based on biomass and check-tray observations.<br>• Disease Diagnosis: External examination of prawns for signs of "Black Spot" disease, "White Tail Disease," and epibiont (peritrich ciliate) fouling. | **10 Hrs** |
| **III** | • Processing: Icing, de-heading, and calculating the "Tail Yield" of prawns.<br>• Project Planning: Preparation of a budget estimate for a small-scale (1 hectare) Scampi farm. | **10 Hrs** |

## Recommended References


1. Dongre S.B, Chinte D.N, Wagh D C and Shejwal P M (2026) Text Book of Freshwater Prawan Cullture, Eductional Publishing ,Chhatrapati Sambhajinagar(MS) India.
2. New, M. B. (2002). *Farming Freshwater Prawns: A Manual for the Culture of the Giant River Prawn*. FAO Fisheries Technical Paper No. 428. (The "Gold Standard" for practical protocols).
3. Sakhare V. B(2012) Inland Fisheries ,Daya Puplishing House,New Delhi.
4. CIFE Manual (2011). *Hatchery and Culture Management of Macrobrachium rosenbergii*. ICAR-Central Institute of Fisheries Education, Mumbai.
5. Adiyodi, K. G. (2005). *Practical Manual of Invertebrate Zoology*. (For anatomical studies).
6. Kurian, C. V. and Sebastian, V. O. (1993). *Prawns and Prawn Fisheries of India*. Hindustan Publishing Corporation.
7. Reddy, A. K. (2011). *Freshwater Prawn Farming*. ICAR Publication.
8. Ayyappan, S. (2011). *Handbook of Fisheries and Aquaculture*. ICAR, New Delhi.

## SUB/Mn/T/300: INTEGRATED FISH FARMING SYSTEM

Total Credits : 02

Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To teach the biological and chemical concepts of nutrient recycling, energy flow, and trophic relationships within a combined farming system.
- To study the structural design, stocking densities, and management of various integrated models (e.g., Paddy-cum-Fish, Pig-cum-Fish, Poultry-cum-Fish, Duck-cum-Fish, and Cattle-cum-Fish).
- To analyze the chemical composition of livestock manure and calculate its safe loading rate into fish ponds to prevent eutrophication (oxygen depletion from excess nutrients).
- To demonstrate how integration reduces production costs by eliminating external inputs like commercial fish feed and artificial fertilizers.
- To evaluate integrated farming as a climate-smart strategy that secures food production and reduces financial risk for small-scale and marginal farmers.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Blueprint an integrated farm layout that matches regional topography, water availability, and local market demands.
- Mathematically determine the exact number of livestock units (birds, pigs, or cattle) required to naturally fertilize a given acreage of a fish pond.
- Implement specialized water-management and trench-digging techniques to successfully raise fish inside traditional paddy fields.
- Compare the financial returns of standalone fish farming against integrated models to demonstrate increased profitability per unit area.
- Utilize traditional and modern natural farming principles to produce residue-free fish and crops, aligning with global green-agriculture trends.
- Guiding rural farmers toward sustainable livelihood models.
- Designing government schemes aimed at doubling farmers' income through diversification.
- Advising agricultural firms on zero-waste production methods

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | **Concepts and Principles of IFFS:**<br>• Introduction: Definition, history, scope, and significance of integrated farming.<br>• Basic Principles: Recycling of organic wastes and nutrients; energy flow in an integrated ecosystem.<br>• Advantages: Economic viability, employment generation, risk minimization, and environmental sustainability.<br>**Livestock-Fish Integration:**<br>• Cattle-Fish Farming: Housing layout, waste diversion, stocking densities of fish, and nutrient load management. | **10 Hrs** |

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| | • Pig-Fish Farming: Pig breeds suited for integration, waste generation metrics, and pond management.<br>• Poultry/Duck-Fish Farming: Design of over-pond or shoreline poultry coops; benefits of duck droppings and duck foraging on pond health. | |
| **II** | **Agri/ Horti-Fish Integration:**<br>• Paddy-Fish Culture: Systems of rice-fish culture (simultaneous vs. rotational); field modifications (trenches, peripheral canals); suitable fish species.<br>• Horticulture-Fish Farming: Utilizing pond embankments for vegetables, fruits (banana, papaya), and flowers.<br>• Mushroom & Vermicomposting: Integrating spent mushroom substrate and earthworm compost into the pond productivity cycle.<br>**Specialized and Modern Integrated Trends:**<br>• Aquaponics: Principles of closed-loop recirculating aquaponic systems; Nitrogen cycle mechanics; Hydroponic plant subsystems (NFT, DWC, and Media beds).<br>• Biofloc and Peri-phyton Integration: Managing carbon-to-nitrogen (C:N) ratios to optimize heterotrophic bacterial protein production alongside standard crops.<br>• Sewage-Fed Fisheries: Biology and economics of wastewater aquaculture (e.g., East Kolkata Wetlands model); Natural purification steps and microbiological safety boundaries. | **10 Hrs** |
| **III** | **Socio-Economics, Economics, and Planning**<br>• Feasibility and Modeling: Designing a bio-economically viable 1-hectare integrated farm model; Net Present Value (NPV) and input-output flow calculations.<br>• Socio-Economic Impact: Food security, circular rural economy generation, gender participation in micro-enterprises.<br>• Policies and Extension: Institutional financing, government subsidies (e.g., under PMMSY), and sustainable development goals (SDGs). | **10 Hrs** |

**RECOMMENDED TEXTBOOKS AND REFERENCES**


1. Jhingran, V. G. (1991). *Fish and Fisheries of India*. Hindustan Publishing Corporation. (Includes foundational chapters on integrated farming in India).
2. Edwards, P., Pullin, R. S. V., & Gartner, J. A. (1988). *Research and Education in Integrated Agriculture-Aquaculture Farming Systems*. ICLARM.
3. Govindan, T. K. (1985). *Integrated Fish Farming*. ICAR Publication, New Delhi.
4. Chakrabarti, N. M. (1998). *Integrated Fish Farming Systems*. Narendra Publishing House.

**SUB/Mn/T/301: WASTE MANAGEMENT AND CO-PRODUCT SYSTEM**

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To understand the environmental impacts of seafood processing wastes and learn to quantify pollution indices like BOD, COD, and TDS.
- To learn the technological processes for transforming raw processing discards into high-volume traditional by-products like fish meal, oil, and silage.
- To acquire advanced bioprocessing concepts to isolate high-value molecules (collagen, chitosan, and bioactive peptides) from shell and bone waste.
- To evaluate the design mechanics of industrial Effluent Treatment Plants (ETPs) and bio-energy generation units.
- To formulate business models that utilize Intellectual Property Rights (IPR) and HACCP boundaries to achieve 100% processing biomass utilization.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Quantify and Assess industrial effluent metrics (BOD/COD) to verify regulatory environmental safety compliance.
- Formulate and Prepare standardized organic or fermented fish silage models matching raw material characteristics.
- Optimize multi-variable extraction parameters (temperature, chemical concentrations) to isolate high-purity medical-grade biopolymers.
- Design a functional waste-to-resource workflow that incorporates waste reduction protocols and hazard analysis (HACCP).

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | **Characterization and Dynamics of Processing Waste**<br>• Types and Sources of Waste: Classification of solid and liquid waste from seafood processing plants, landing centers, and aquaculture farms.<br>• Proximate Composition of W<br>• aste: Nutritional and chemical profiles of processing discards (head, viscera, skin, scales, and bones).<br>• Environmental Indices: Understanding Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), and effluent discharge thresholds.<br>**Traditional By-Product Processing**<br>• Fish Meal and Oil Production: Raw material preparation, cooking, pressing, separation, and drying; quality metrics for commercial fish meal and stabilizing fish body/liver oils.<br>• Fish Silage: Principles of preservation using organic acids (formic/propionic) vs. fermented silage using lactic acid bacteria; nutritional profile and applications in animal feed.<br>• Curing and Drying By-products: Scaling up local techniques for processing swim bladders (isinglass), | **10 Hrs** |

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| | shark fins, and fish skins | |
| II | **Extraction of High-Value Macromolecules**<br>• Chitin and Chitosan Extraction: Chemical demineralization, deproteinization, and deacetylation of shrimp and crab shell wastes; modern enzymatic extraction methods.<br>• Marine Collagen and Gelatin: Extraction protocols from fish skin, scales, and bones; functional properties and biomedical applications.<br>• Bioactive Peptides: Controlled enzymatic hydrolysis of fish frame protein; isolation of antioxidant, antihypertensive, and antimicrobial peptides.<br>**Liquid Waste Treatment and Bio-Energy**<br>• Effluent Treatment Plant (ETP) Design: Primary (screening, sedimentation), secondary (activated sludge, trickling filters), and tertiary water treatment systems.<br>• Anaerobic Digestion: Conversion of organic processing waste into biogas (methane) and organic slurry fertilizers.<br>• Biodiesel Production: Transesterification processes using non-edible oils and waste fish lipids. | **10 Hrs** |
| III | **Bio-Economics, Quality Assurance, and IPR**<br>• HACCP in By-Product Plants: Hazard analysis and critical control points specific to rendering and extraction plants.<br>• Traceability and Regulations: Modern cold-chain tracking; national and international laws governing the trade of marine co-products.<br>• Circular Bio-Economy: Intellectual Property Rights (IPR) for novel bio-products; structural economic models for 100% biomass utilization. | **10 Hrs** |

**RECOMMENDED TEXTBOOKS AND REFERENCES**


1. Balachandran, K. K. (2001). *Post-harvest Technology of Fish and Fish Products.* Daya Publishing House. *(Excellent foundation for traditional by-*
2. *products).*Gopakumar, K. (2002). *Textbook of Fish Processing Technology.* ICAR, New Delhi. *(Contains standard protocols for Indian processing standards).*
3. Kim, S. K. (Ed.). (2014). *Seafood Processing By-Products: Functional Food and Bioactive Compounds.* Springer. *(The definitive guide for Unit 3's high-value molecule extraction).*Bre
4. mner, H. A. (2002). *Safety and Quality Issues in Fish Processing.* Woodhead Publishing.
5. Hall, G. M. (1997). *Fish Processing Technology.* Blackie Academic & Professional.
6. ICAR-CIFT. *Training Manual on Value Added Products and Byproducts from Fish.* Central Institute of Fisheries Technology, Kochi.

**SUB/VSC/T/300: FISH FEED FORMULATION**

Total Credits : 02 | Total Contact Hours : 30 Hrs | Maximum Marks : 50

**Learning Objectives of the Course:**

- To study the role of proteins, lipids, carbohydrates, vitamins, and minerals in the growth and health of various fish and shellfish species.
- To familiarize students with diverse feed ingredients, including animal-based, plant-based, and non-conventional sources (like insects or microbial proteins).
- To teach various mathematical and computational methods (such as the Pearson Square Method or Linear Programming) for balanced feed formulation.
- To understand the mechanical processes of feed production, including grinding, mixing, pelleting, and extrusion (sinking vs. floating feeds).
- To teach the methods of assessing feed efficiency using biological indices like FCR (Feed Conversion Ratio) and PER (Protein Efficiency Ratio).

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Recommend precise nutrient levels for different life stages (larvae, fry, fingerling, and broodstock) across various species.
- Detect and suggest methods to neutralize harmful substances in plant-based ingredients (like gossypol or trypsin inhibitors).
- Independently calculate feed formulas that meet specific nutritional targets at the lowest possible cost.
- Evaluate the physical properties of feed, such as water stability, buoyancy, and pellet durability index (PDI).
- Design effective feeding regimes and schedules on a farm, minimizing waste and environmental impact (nutrient leaching).

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | **Fundamentals of Fish Nutrition**<br>• Nutritional Requirements: Essential amino acids, fatty acids (omega-3 and omega-6), vitamins, and minerals required by finfish and shellfish.<br>• Energy Metabolism: Gross energy, digestible energy, and metabolizable energy; Protein-to-Energy (P:E) ratio.<br>• Digestive Physiology: Comparative anatomy of the digestive systems of herbivorous, carnivorous, and omnivorous fishes; Role of digestive enzymes.<br>**Feed Ingredients and Raw Materials**<br>• Protein Sources: Conventional (Fish meal, Soybean meal) vs. Non-conventional (Insect meal, Single Cell Protein, Distillers Dried Grains with Solubles - DDGS).<br>• Energy Sources: Cereals (Corn, Wheat, Rice bran) and Lipids (Fish oil, Vegetable oils). | **10 Hrs** |

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| | • Feed Additives: Attractants, binders, antioxidants, preservatives, and immunostimulants.<br>• Application of probiotics in aquaculture<br>• Anti-nutritional Factors: Identifying and neutralizing factors like trypsin inhibitors, phytates, and gossypol in plant-based ingredients. | |
| **II** | **Feed Formulation Techniques**<br>• Formulation Principles: Balancing nutrients while minimizing cost (Least-Cost Formulation).<br>• Mathematical Methods: Pearson's Square method, Algebraic equations, and introduction to linear programming software.<br>• Life-stage Specific Feeds: Formulation of larval/starter feeds, grower feeds, and broodstock diets.<br>**Feed Manufacturing Technology**<br>• Processing Steps: Grinding, sifting, mixing, and conditioning.<br>• Pelleting Technology: Difference between Steam Pelleting (sinking feed) and Extrusion Cooking (floating feed).<br>• Post-processing: Drying, cooling, and fat coating (vacuum coating).<br>• Micro-encapsulation: Techniques for producing specialized larval diets. | **10 Hrs** |
| **III** | **Feed Quality and Management**<br>• Physical Quality: Pellet durability index (PDI), water stability, and buoyancy.<br>• Storage and Stability: Factors affecting feed quality during storage (moisture, temperature, pests, and lipid oxidation).<br>• Feeding Strategies: Ration calculation, feeding frequency, and use of demand feeders vs. automatic feeders.<br>• Economic Evaluation: Feed Conversion Ratio (FCR), Protein Efficiency Ratio (PER), and Feed Efficiency (FE). | **10 Hrs** |

## Recommended Textbooks and References


1. Halver, J. E., & Hardy, R. W. (2002). *Fish Nutrition*. Academic Press. (The definitive global reference).
2. Hertrampf, J. W., & Piedad-Pascual, F. (2000). *Handbook on Ingredients for Aquaculture Feeds*. Kluwer Academic Publishers.
3. Lovell, R. T. (1998). *Nutrition and Feeding of Fish*. Kluwer Academic Publishers.
4. Houlihan, D., et al. (2001). *Food Intake in Fish*. Blackwell Science.
5. NRC (National Research Council) (2011). *Nutrient Requirements of Fish and Shrimp*. National Academies Press.
6. Guillaume, M., et al. (2001). *Nutrition and Feeding of Fish and Crustaceans*. Praxis Publishing.
7. De Silva, S. S., & Anderson, T. A. (1995). *Fish Nutrition in Aquaculture*. Chapman & Hall.
8. ICAR-CIFE Manual. *Fish Feed Technology*. Central Institute of Fisheries Education.

## SUB/VSC/T/301: FUNDAMENTAL OF FISH MICROBIOLOGY

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To study the classification, morphology, and physiology of microorganisms found in freshwater, brackish, and marine environments.
- To understand the role of microbes in nutrient cycling (Nitrogen, Carbon, and Phosphorus cycles) within aquaculture ponds.
- To identify major microbial pathogens (Bacteria, Viruses, Fungi) and understand their mode of infection and transmission in fish and shellfish.
- To study the role of microorganisms in the post-harvest spoilage of fish and the principles of microbial control.
- To explore the application of probiotics and bioremediation agents in maintaining aquatic health and improving growth.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Classify aquatic microorganisms based on their structural and biochemical characteristics.
- Apply knowledge of the Nitrogen Cycle to manage water quality, particularly in controlling toxic ammonia and nitrite levels.
- Recognize the clinical signs of major microbial diseases (such as Furunculosis, Vibriosis, or Epizootic Ulcerative Syndrome) and understand their causative agents.
- Explain the microbiological basis of fish preservation techniques and implement hygiene protocols in processing units.
- Evaluate and use beneficial bacterial cultures to enhance fish immunity and pond soil quality.
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| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | **Introduction to Aquatic Microbiology:**<br>• Scope and History: Development of fish microbiology; importance in aquaculture and public health.<br>• Aquatic Environment: Distribution of microorganisms in fresh, brackish, and marine ecosystems.<br>• Microbial Groups: General characteristics of bacteria, viruses, fungi, and protists significant to fisheries.<br><br>**Morphology and Biology of Fish Pathogens:**<br>• Bacterial Pathogens: Morphological and biochemical characteristics of *Aeromonas*, *Vibrio*, *Pseudomonas*, *Flavobacterium*, and *Edwardsiella*.<br>• Viral Pathogens: Introduction to major fish viruses: IPNV (Infectious Pancreatic Necrosis Virus), VHSV, | **10 Hrs** |

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| | and Betanodavirus.<br>• Fungal Pathogens: Biology of *Saprolegnia* and *Aphanomyces invadans* (EUS). | |
| **II** | **Microbiology of Fish Products and Spoilage:**<br>• Microbial Spoilage: Mechanisms of spoilage; succession of bacteria during fish storage.<br>• Indicators of Quality: Coliforms, *E. coli*, and *Enterococci* as indicators of fecal contamination.<br>• Foodborne Pathogens: Study of *Salmonella*, and *Vibrio parahaemolyticus* in seafood.. | **10 Hrs** |
| **III** | **Techniques in Fish Microbiology:**<br>• Microscopy: Principles of Light, Phase-contrast, and Electron microscopy.<br>• Staining Techniques: Gram staining, Acid-fast staining, and Capsule staining.<br>• Molecular Diagnostics: Introduction to PCR (Polymerase Chain Reaction) and ELISA in fish disease diagnosis | **10 Hrs** |

## Recommended Textbooks and References


1. Austin, B., & Austin, D. A. (2016). *Bacterial Fish Pathogens: Disease of Farmed and Wild Fish*. Springer. (The primary reference for fish bacteriology).
2. Rheinheimer, G. (1992). *Aquatic Microbiology*. John Wiley & Sons.
3. Roberts, R. J. (2012). *Fish Pathology*. Wiley-Blackwell.
4. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2001). *Microbiology*. Tata McGraw-Hill. (For foundational microbial concepts).
5. FAO Fisheries Technical Paper. *Manual on Diagnostic Techniques in Fish Diseases*.
6. Bullock, G. L. (1986). *Bacterial Diseases of Fish*. T.F.H. Publications.
7. Inglis, V., Roberts, R. J., & Bromage, N. R. (1993). *Bacterial Diseases of Fish*. Blackwell Science.
8. ICAR-CIFE. *Laboratory Manual on Aquatic Microbiology*.

## SUB/VSC/P/326: FISH FEED FORMULATION

Total Credits : 02

Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To train students in the laboratory analysis of feed ingredients for moisture, protein, lipid, ash, and fiber content.
- To evaluate locally available agricultural by-products (e.g., rice bran, oil cakes, silkworm pupae) for their nutritional potential.
- To provide hands-on experience using the Pearson Square method and computer-based spreadsheets for balancing nutrient ratios.
- To teach the manual and mechanical processes of grinding, mixing, pelletizing, and drying fish feed.
- To study the water stability and buoyancy of feeds to ensure they remain intact until consumed by the fish.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Perform basic biochemical tests to determine the crude protein and fat levels of various raw materials.
- Independently calculate a feed recipe that meets the 30%–35% protein requirement for carps or higher for carnivorous species.
- Safely use lab-scale pelletizers and grinders to produce uniform sinking and floating pellets.
- Measure the "Disintegration Time" of pellets in water to ensure minimal nutrient leaching and water pollution.
- Use data from feeding trials to calculate the Feed Conversion Ratio (FCR) and Specific Growth Rate (SGR).
- Graduates will be proficient in feed testing and quality control laboratories.
- Students will have the capability to set up a small-scale "farm-made feed" unit, significantly reducing production costs for local farmers.
- Ability to advise on ingredient substitution (using cheaper local alternatives) without compromising on fish growth.
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| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | • Determination of Moisture Content using the hot-air oven method.<br>• Estimation of Crude Protein using the Micro-Kjeldahl method.<br>• Estimation of Crude Lipid using the Soxhlet extraction apparatus.<br>• Pearson's Square Method: Formulating a two-ingredient diet to meet a specific protein target. | **10 Hrs** |

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| **II** | • Requirement Calculation: Calculating the Daily Feed Allowance (DFA) based on biomass, water temperature, and fish size.<br>• Pelleting: Production of Sinking Pellets using a laboratory-scale pelletizer.<br>• Water Stability Test: Measuring the disintegration time of pellets in water to ensure minimal nutrient leaching. | **10 Hrs** |
| **III** | Demonstration of the Extrusion process for floating feeds (if facilities permit) or site visit to a feed mill.<br>• Growth Indices Calculation:<br>➢ FCR (Feed Conversion Ratio).<br>➢ SGR (Specific Growth Rate).<br>➢ PER (Protein Efficiency Ratio).<br>• Gastric Evacuation Study: Simple experiment to determine the time taken for the stomach to empty, aiding in feeding frequency scheduling. | **10 Hrs** |

**Recommended Practical References**


1. AOAC International (2016). *Official Methods of Analysis of AOAC International*. (The global standard for proximate analysis).
2. CIFE Manual (2015). *Laboratory Manual on Fish Nutrition and Feed Technology*. ICAR-Central Institute of Fisheries Education.
3. New, M. B. (1987). *Feed and Feeding of Fish and Shrimp: A Manual on the Preparation and Presentation of Compound Feeds for Shrimp and Fish in Aquaculture*. FAO ADCP/REP/87/26.
4. Halver, J. E., & Hardy, R. W. (2002). *Fish Nutrition*. Academic Press.
5. Hertrampf, J. W., & Piedad-Pascual, F. (2000). *Handbook on Ingredients for Aquaculture Feeds*. Kluwer Academic Publishers.

## SUB/VSC/P/327: FUNDAMENTAL OF FISH MICROBIOLOGY

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To train students in the fundamental rules of microbiology, including sterilization (autoclaving), disinfection, and the handling of microbial cultures without contamination.
- To provide hands-on experience in microscopy, including various staining techniques (Gram staining) to differentiate between bacterial groups.
- To teach the methods of isolating bacteria from fish organs (gill, kidney, liver) and water samples using selective and differential media.
- To master techniques like the Total Plate Count (TPC) to assess the sanitary quality of water and fish products.
- To observe the practical application of microbiology in disease prevention and water treatment at commercial aquaculture sites.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Competently use microscopes, incubators, laminar airflows, and autoclaves for microbiological research.
- Characterize bacteria based on shape (cocci, bacilli) and Gram reaction (Positive vs. Negative), which is the first step in disease diagnosis.
- Isolate common fish pathogens like *Aeromonas* or *Vibrio* from infected samples and perform basic biochemical tests (Catalase, Oxidase) for identification.
- Analyze pond water for coliform bacteria to determine if the environment meets safety standards for aquaculture.
- Design a hygiene and sanitation protocol for a hatchery or processing unit based on microbial risk assessment.
- Students will be ready to work in aquatic animal health laboratories.
- Graduates will be equipped to monitor microbial standards in seafood export units.
- Ability to maintain a pathogen-free environment in high-intensity farming systems.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | • Microscopy: Use and maintenance of the compound microscope; calibration of ocular micrometer.<br>• Sterilization and Disinfection: Principles and operation of the Autoclave, Hot Air Oven, and Laminar Air Flow (LAF).<br>• Staining Methods: Simple staining, Gram staining (to differentiate between Gram-positive and Gram-negative bacteria), and Acid-fast staining.<br>• Sampling Techniques: Aseptic collection of samples from fish skin, gills, kidney, and intestine.<br>• Pure Culture Techniques: Streak plate, spread plate, and pour plate methods.<br>• | **10 Hrs** |

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| | • Identification of Pathogens: Presumptive identification of *Vibrio*, *Aeromonas*, and *Pseudomonas* from diseased fish. | |
| **II** | • Bacteriological Analysis of Pond Water: Estimation of Total Plate Count (TPC).<br>• Assessment of Fecal Contamination: Determination of Most Probable Number (MPN) for Coliforms in aquaculture ponds.<br>• Minimum Inhibitory Concentration (MIC): Basic demonstration of determining the lowest concentration of an atimicrobial that inhibits growth. | **10 Hrs** |
| **III** | • Spoilage Indicators: Determination of TPC in fresh vs. spoiled fish samples.<br>• Detection of Foodborne Pathogens: Enrichment and isolation of *Salmonella* or *Vibrio parahaemolyticus* from seafood samples (demonstration).<br><br>**Field Visit:** Aquatic Health Diagnostic Lab or Modern Fish Hatchery: To observe real-world disease diagnostic procedures. | **10 Hrs** |

**Recommended Practical Manuals & Textbooks**


1. Austin, B., & Austin, D. A. (2016). *Bacterial Fish Pathogens: Disease of Farmed and Wild Fish*. Springer. (Technical protocols for identification).
2. Aneja, K. R. (2007). *Experiments in Microbiology, Plant Pathology and Biotechnology*. New Age International. (Excellent for general microbial techniques).
3. Cappuccino, J. G., & Welsh, C. (2017). *Microbiology: A Laboratory Manual*. Pearson.
4. ICAR-CIFE Manual. *Laboratory Manual on Aquatic Microbiology*. Central Institute of Fisheries Education.
5. Roberts, R. J. (2012). *Fish Pathology*. Wiley-Blackwell.
6. Rheinheimer, G. (1992). *Aquatic Microbiology*. John Wiley & Sons.
7. Pelczar, M. J., et al. (2001). *Microbiology*. Tata McGraw-Hill.

**SUB/FP/CEP/T/326: AQUACULTURE AND FARM MANAGEMENT**

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To introduce students to various types of aquaculture (monoculture, polyculture, integrated farming) and different intensities (extensive, semi-intensive, intensive).
- To teach the scientific criteria for selecting sites and the engineering principles behind pond construction, dyke design, and water inlet/outlet systems.
- To study the criteria for selecting "culturable" species and the biology of major Indian and exotic carps, catfishes, and air-breathing fishes.
- To provide expertise in pre-stocking (liming, fertilization), stocking, and post-stocking (feeding, aeration, health monitoring) management.
- To understand the economics of farm operations, record-keeping, and the environmental regulations governing aquaculture.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Independently draft a blueprint for a fish farm, including pond layout, water supply channels, and drainage systems based on soil and water topography.
- Implement strategies to maintain optimal Dissolved Oxygen (DO), pH, and alkalinity levels to ensure maximum fish growth and survival.
- Calculate and execute appropriate stocking densities and polyculture ratios (e.g., Catla-Rohu-Mrigal combinations) to utilize all ecological niches of a pond.
- Identify common farm-level problems, such as algal blooms, oxygen depletion, and behavioral signs of stress or disease in fish.
- Perform cost-benefit analyses, calculate Feed Conversion Ratios (FCR), and manage farm accounts to ensure a profitable venture.
-

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | **Principles of Aquaculture**<br>• Basics of Aquaculture: Definition, history, and scope; Comparison between aquaculture and capture fisheries.<br>• Classification of Aquaculture: Based on salinity (Freshwater, Brackishwater, Marine); Based on intensity (Extensive, Semi-intensive, Intensive, Super-intensive).<br>• Culturable Species: Criteria for selection of candidate species; Introduction to major species (Indian Major Carps, Tilapia, Catfish, Shrimps, and Seaweeds).<br>**Farm Design and Construction**<br>• Site Selection: Topography, soil quality (pH, texture), and water availability; Socio-economic considerations.<br>• Pond Engineering: Types of ponds (Nursery, Rearing, Stocking, Broodstock); Design and construction of | **10 Hrs** |

| | | |
|---|---|---|
| | dikes, canals, and sluice gates.<br>• Aeration and Water Supply: Principles of aeration; Types of aerators (Paddlewheel, Aspirators); Water intake and filtration systems. | |
| **II** | **Seed Production and Nursery Management**<br>• Brood stock Management: Selection, conditioning, and nutrition of parent fish.<br>• Induced Breeding: Principles of hypophysation; Synthetic hormones (Ovaprim, Ovatide); Hatchery types (Chinese circular hatchery, Jar hatchery).<br>• Nursery Management: Pond preparation (liming, fertilization); Eradication of weed fish and insects; Stocking and post-stocking care.<br>**Culturing Practices and Systems**<br>• Polyculture: Principles of composite fish culture; Ecological niches and species compatibility.<br>• Integrated Farming Systems (IFS): Integration of fish with livestock (Poultry, Pig, Cattle) and crops (Paddy-cum-fish).<br>• Modern Systems: Introduction to Biofloc Technology (BFT), Recirculating Aquaculture Systems (RAS), and Cage/Pen culture. | **10 Hrs** |
| **III** | **Farm Management and Economics**<br>• Feeding Management: Natural food production (plankton) vs. artificial feeding; Feeding schedules and FCR.<br>• Water Quality Management: Monitoring pH, Dissolved Oxygen (DO), Ammonia, and Alkalinity; Remediation techniques.<br>• Farm Economics: Capital and operational costs; Cost-benefit analysis; Record keeping and marketing strategies. | **10 Hrs** |

## Recommended Textbooks and References


1. Jhingran, V. G. (1991). *Fish and Fisheries of India*. Hindustan Publishing Corporation. (The foundational text for Indian aquaculture).
2. Pillay, T. V. R., & Kutty, M. N. (2005). *Aquaculture: Principles and Practices*. Blackwell Publishing. (A global standard).
3. Wheaton, F. W. (1993). *Aquacultural Engineering*. John Wiley & Sons.
4. Ayyappan, S. (2011). *Handbook of Fisheries and Aquaculture*. ICAR, New Delhi.
5. Bardach, J. E., et al. (1972). *Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms*. Wiley-Interscience.
6. Huet, M. (1994). *Textbook of Fish Culture: Breeding and Cultivation of Fish*. Fishing News Books.
7. Santhanam, R., et al. (1987). *A Manual of Freshwater Aquaculture*. Oxford & IBH Publishing.
8. FAO Training Series. *Simple Methods for Aquaculture* (Soil, Water, Pond Construction, Management).

**SUB/FP/CEP/ P/326: AQUACULTURE AND FARM MANAGEMENT**

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To introduce students to various types of aquaculture (monoculture, polyculture, integrated farming) and different intensities (extensive, semi-intensive, intensive).
- To teach the scientific criteria for selecting sites and the engineering principles behind pond construction, dyke design, and water inlet/outlet systems.
- To study the criteria for selecting "culturable" species and the biology of major Indian and exotic carps, catfishes, and air-breathing fishes.
- To provide expertise in pre-stocking (liming, fertilization), stocking, and post-stocking (feeding, aeration, health monitoring) management.
- To understand the economics of farm operations, record-keeping, and the environmental regulations governing aquaculture.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Independently draft a blueprint for a fish farm, including pond layout, water supply channels, and drainage systems based on soil and water topography.
- Implement strategies to maintain optimal Dissolved Oxygen (DO), pH, and alkalinity levels to ensure maximum fish growth and survival.
- Calculate and execute appropriate stocking densities and polyculture ratios (e.g., *Catla-Rohu-Mrigal* combinations) to utilize all ecological niches of a pond.
- Identify common farm-level problems, such as algal blooms, oxygen depletion, and behavioral signs of stress or disease in fish.
- Perform cost-benefit analyses, calculate Feed Conversion Ratios (FCR), and manage farm accounts to ensure a profitable venture.
-

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | • Soil Quality Analysis: Determination of soil texture (pipette method), pH, and organic carbon content.<br>• Water Quality Analysis: Hands-on estimation of Dissolved Oxygen (Winkler's method), Alkalinity, Hardness, and Ammonia (NH3-N).<br>• Design and layout of fish farm: Preparation of a layout plan for a 1-hectare farm, including nursery, rearing, and stocking ponds.<br>• Aquatic Weed and Insect Control: Identification of common aquatic weeds and aquatic insects.<br>• Induced Breeding: Preparation of pituitary gland extract; demonstration of synthetic hormone injection (Ovaprim/Ovatide) in carps. | **10 Hrs** |

| | | |
|---|---|---|
| **II** | • Collection and identification of Zooplankton and Phytoplankton's.<br>• Morphometric study (available fish) : Monthly sampling of fish to record length and weight; calculation of Mean Body Weight (MBW). | **10 Hrs** |
| **III** | • Harvesting Techniques: Operation of drag nets (seine nets), cast nets, and gill nets.<br><br>**Field Project Report**: Preparation of a techno-economic feasibility report for a small-scale fish farm.<br><br>• Visit to fish hatchery centre to prepare the project report and submitted the practical examination. | **10 Hrs** |

## Recommended Practical References


1. Ayyappan, S. (2011). *Handbook of Fisheries and Aquaculture*. ICAR, New Delhi. (Comprehensive field guide).
2. Jhingran, V. G. (1991). *Fish and Fisheries of India*. Hindustan Publishing Corporation. (Includes detailed procedural notes).
3. Sakhare V. B(2012) Inland Fisheries ,Daya Puplishing House,New Delhi.
4. Sakhare V. B(2007) Applied Fisheries ,Daya Puplishing House,New Delhi.
5. FAO Training Series. *Simple Methods for Aquaculture (Pond Construction, Water, Soil)*. (Available online, excellent for beginners).
6. CIFE Manual. *Manual on Freshwater Aquaculture*. ICAR-Central Institute of Fisheries Education.
7. Wheaton, F. W. (1993). *Aquacultural Engineering*. John Wiley & Sons.
8. Pillay, T. V. R., & Kutty, M. N. (2005). *Aquaculture: Principles and Practices*. Blackwell Publishing.
9. Santhanam, R., et al. (1987). *A Manual of Freshwater Aquaculture*. Oxford & IBH Publishing.

# DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY
# CHHATRAPATI SAMBHAJI NAGAR

**B.Sc. III. Year Sem- V Practical Examination-March/April 20**

**Course code: - Fishery**

**(Based on Theory paper Paper No. 300)**

**SUB/DSC/P/ 326**

**Centre Name:** **Batch. No.**

**Time:-** 4 Hours **Total marks**: 30 (External) + 20 (Internal) = **50 Marks**

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**(Perform any ONE of the following experiments allotted to you by the examiner)**

**Q. 1.** Calculate the required C:N ratio for a Biofloc unit based on the provided feed protein content (X%). Demonstrate the step-by-step preparation of the inoculum using a carbon source and probiotics.

**[10 Marks]**

**OR**

Determine and compare the Dissolved Oxygen (DO) / Ammonia (NH3) / pH of the given water sample using both the traditional titration method and a digital multi-parameter probe. Comment on the efficiency and calibration of the digital probe.

Q.2 Isolate and extract genomic DNA from the given fish tissue (fin clips/scales) and explain the steps of visualising DNA using Agarose Gel Electrophoresis.

**[10 Marks]**

**OR**

Interpret the provided satellite-based Sea Surface Temperature (SST) and Chlorophyll-a maps to identify and demarcate the Potential Fishing Zones (PFZ). Estimate the fish school depth and biomass using the provided mock echo-gram data.

Q.3 Perform the Organoleptic (sensory) evaluation and Total Volatile Base Nitrogen (TVB-N) analysis of the two provided fish samples (Fresh vs. Chilled fish) to determine their quality state.

**[10 Marks]**

**(OR)**

Demonstrate the preparation of fish silage from fish processing waste using organic acids, and explain the impacts of Smart Packaging (Vacuum/MAP) on shelf life.

**Internal Marks-**

| | |
|---|---|
| Q.4 -Excursion tour report/Slide/Sample collection/submission. | **05** |
| Q.5- Record Book. | **05** |
| Q.6- punctuality and antecedence. | **05** |
| Q.7. Viva-Voce. | **05** |

**Internal Examiner** **External Examiner**

## DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY
## CHHATRAPATI SAMBHAJI NAGAR

**B.Sc. III. Year Sem- V Practical Examination-March/April 20**

**Course code: - Fishery**

**(Based on Theory paper Paper No. 301)**

**SUB/DSC/P/ 327**

**Centre Name:** **Batch. No.**

**Time:-** 4 Hours **Total marks**: 30 (External) + 20 (Internal) = **50 Marks**

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**(Perform any ONE of the following experiments allotted to you by the examiner)**

Q 1.Estimate the freshness of the given fish sample using the Quality Index Method (QIM). Systematically evaluate and record the score for eyes, gills, skin texture, and odor. Comment on its post-mortem stage (Rigor Mortis, Autolysis, or Spoilage) and processing suitability.

**(10 Marks)**

**OR**

Perform dressing on the given whole fish. Prepare clean fillets or steaks, record the respective weights, and calculate the final Dressing Percentage relative to the whole body weight.

Q2.Determine the moisture content of the provided sun-dried vs. mechanically dried fish product. Write down the principle, steps, and final comparative calculations.

**(10 Marks)**

**OR**

Calculate the Chlorine Demand Estimation required for the provided process water sample to ensure proper plant sanitation. Briefly outline the steps required for a HACCP flow chart for this line.

Q.3. Prepare a batch of value-added fishery products (either Fish Pickles, Fish Wafers/Crackers, or Fish Fingers) using the ingredients provided.

**(10 Marks)**

**OR**

Write down the step-by-step technological flow sheet, note the hygiene protocols maintained during preparation, and present the final product for organoleptic assessment.

**Internal Marks-**

| | |
|---|---|
| Q.4 -Excursion tour report/Slide/Sample collection/submission. | **05** |
| Q.5- Record Book. | **05** |
| Q.6- punctuality and antecedence. | **05** |
| Q.7. Viva-Voce. | **05** |

**Internal Examiner** **External Examiner**

# B.Sc.

# Fishery Science

# Third Year

# (Semester VI$^{th}$)

**Structure of B. Sc. (Three / Four Years Honours / Honours with Research Degree) Programme with Multiple Entry and Exit Options**
**Subject (Major): Fishery Science**
**B.Sc. Third Year: 6th Semester**

| Course Type | Course Code | Examination Code (To be given by Respective BoS) | Course Name | Teaching Scheme ( Hrs / Week) | | Credits Assigned | | Total Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory | Practical | Theory | Practical | |
| Major (Core) Mandatory DSC | SUB/DSC/T/ 350 | SAC03113506T | Fish Biology | 2 | | 2 | | 2+2+2+2+ 2 =10 |
| | SUB/DSC/T/ 351 | SAC03113516T | Fish Economics | 2 | | 2 | | |
| | SUB/DSC/P/ 376 | SAC03113766P | Practical based on SUB/DSC/T/350 | | 4 | | 2 | |
| | SUB/DSC/P/ 377 | SAC03113776P | Practical based on SUB/DSC/T/351 | | 4 | | 2 | |
| | SUB/DSC/T/ 352 | | IKS-2 ( Indian Knowledge System related to Major) | 2 | | 2 | | |
| Discipline Specific Electives ( DSE) (Choose anyone from SUB/DSE/T/ 350and SUB/DSE/T/351 ) and corresponding Practicals | SUB/DSE/T/ 350 | | Ecology and Resource Management | 2 | | 2 | | 2+2=4 |
| | SUB/DSE/T/ 351 | | Engineering and Post-Harvest Technology | 2 | | 2 | | |
| | SUB/DSE/P/ 376 | | Practical based on SUB/DSE/T/350 | | 4 | | 2 | |
| | SUB/DSE/P/ 377 | | Practical based on SUB/DSE/T/ 351 | | 4 | | 2 | |
| Minor(Choose any one from pool of courses) **It is from different discipline of the same faculty** | SUB/Mn/T/350 | | Advanced Multi-Trophic and Circular Ecosystem | 2 | | 2 | | 2+2=04 |
| | SUB/Mn/T/ 351 | | Socio-Economics and Rural Livehoods | 2 | | 2 | | |
| OJT/ FP/CEP/CC/RP (Choose anyone from pool of courses) | SUB/OJT/P/ 376 | | Fishery Economics and Extension | | 8 | | 4 | 04 |
| | | | | **12** | **20** | **12** | **10** | **22** |

**Exit option: Award of UG degree in Major with 132 credits OR continue with Major and Minor**

## SUB/DSC/T/350: FISH BIOLOGY

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To teach the principles of classification and the identification of major freshwater and marine fish groups using morphological and meristic characteristics.
- To explore the structural organization of fish, including the skeletal, muscular, and integumentary systems.
- To study the functional mechanisms of vital systems such as respiration (gills), circulation, digestion, and osmoregulation.
- To understand the diverse reproductive strategies, life cycles, and developmental stages (egg to adult) of commercially important species.
- To analyze how fish adapt to various aquatic environments through specialized organs like the swim bladder, lateral line system, and electric/luminous organs.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Accurately identify and categorize fish species using dichotomous keys and evolutionary relationships.
- Explain how a fish's body shape, mouth position, and fin structure indicate its habitat and feeding niche.
- Determine how environmental changes (like temperature or salinity) affect fish metabolism and breathing, which is critical for farm management.
- Assess the maturity stages of gonads to predict spawning seasons and manage hatchery operations effectively.
- Use length-weight relationships and age-growth data to assess the health of fish populations in both wild and cultured environments.
- Conducting ecological and physiological studies.
- Understanding reproductive cycles for successful breeding.
- Protecting endangered species based on their biological needs.
- Identifying species during biodiversity surveys and environmental impact assessments.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | **Specialized Anatomy**<br>• Systematics: Principles of fish taxonomy.<br>• Integumentary System: Structure of skin and scales (cycloid, ctenoid, placoid, ganoid); Chromatophores and the mechanism of color change; Bioluminescence in deep-sea fishes.<br>• Muscular System: Myotomes and muscle fiber types (Red vs. White muscle); Physiology of swimming and locomotion. | **10 Hrs** |

| | | |
|---|---|---|
| | **Respiratory and Circulatory Physiology**<br>• Gills and Gas Exchange: Structure of fish gills; Counter-current exchange mechanism.<br>• Air-Breathing Organs: Accessory respiratory organs in *Clarias*, *Anabas*, and *Channa*; Evolutionary significance.<br>• Circulation: Heart structure in Elasmobranchs vs. Teleosts.<br>• Excretion: Kidney structure (Glomerular vs. Aglomerular); Nitrogenous waste excretion (Ammonotelism vs. Ureotelism).<br>• Osmoregulation: Strategies in Freshwater, Marine, and Diadromous (Anadromous/Katadromous) fishes; Role of chloride cells and hormonal control. | |
| **II** | **Reproductive Biology and Development**<br>• Gonad Development: Structure of ovary and testes; Gametogenesis (Oogenesis and Spermatogenesis).<br>• Reproductive Strategies: Oviparity, Viviparity, and Ovoviviparity; Hermaphroditism and Sex Reversal; Parental care in fishes.<br>• Life Cycles: Stages of development from egg to adult; Migration patterns (Anadromy in Salmon, Katadromy in Eels). | **10 Hrs** |
| **III** | **Sensory Biology and Endocrine System**<br>• Sensory Organs: Structure and function of the Lateral Line System; Vision in aquatic environments; Weberian Apparatus and hearing.<br>• Electro-reception: Electric organs and the biology of electric fishes (*Gymnotus*, *Torpedo*).<br>• Endocrinology: Structure and function of the Pituitary, Thyroid, Pancreas, and Ultimobranchial glands; Hormonal regulation of growth and reproduction. | **10 Hrs** |

## Recommended Textbooks and References


1. Bond, C. E. (1996). *Biology of Fishes*. Saunders College Publishing. (The standard international textbook).
2. Sakhre V. B, Chalak A.D and Jetithor S.G(2021) Biology of Inland Fishes ,Discovery Publishing House, New Delhi.
3. Khanna, S. S. & Singh, H. R. (2006). *A Textbook of Fish Biology and Fisheries*. Narendra Publishing House. (Extremely popular for Indian University syllabi).
4. Moyle, P. B., & Cech, J. J. (2004). *Fishes: An Introduction to Ichthyology*. Prentice Hall.
5. Srivastava, C. B. L. (2008). *Fishery Science and Indian Fisheries*. Kitab Mahal.
6. Lagler, K. F., Bardach, J. E., & Miller, R. R. (1977). *Ichthyology*. John Wiley & Sons.
7. Hoar, W. S., & Randall, D. J. *Fish Physiology* (Multi-volume series). Academic Press. (Advanced reference for physiological units).
8. Helfman, G., Collette, B. B., & Facey, D. E. (2009). *The Diversity of Fishes: Biology, Evolution, and Ecology*. Wiley-Blackwell.
9. Norman, J. R., & Greenwood, P. H. (1975). *A History of Fishes*. Ernest Benn Ltd.

## SUB/DSC/T/ 351: FISH ECONOMY

Total Credits : 02

Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To introduce fundamental concepts of micro and macroeconomics specifically applied to fisheries (e.g., laws of supply and demand, diminishing returns).
- To analyze the cost structure of different fishing and aquaculture systems, including fixed costs, variable costs, and break-even points.
- To study the seafood value chain, from "landing center to plate," including the role of middlemen, cooperatives, and cold chain logistics.
- To explore the "Common Property" nature of fisheries and the economic theories behind overfishing and sustainable yield (MSY - Maximum Sustainable Yield).
- To understand the socio-economic status of fishing communities and the impact of government subsidies, insurance, and credit facilities.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Conduct a cost-benefit analysis (CBA) for a proposed aquaculture project or a fishing vessel operation to determine its feasibility.
- Identify price fluctuations in domestic and international markets and understand the factors affecting seafood export-import trends.
- Apply economic models to suggest optimal stocking densities or fishing efforts that maximize profit while maintaining ecological balance.
- Map the supply chain of fish products and identify areas where "value addition" (processing/branding) can increase profit margins.
- Evaluate how national and international policies (like Blue Economy initiatives or WTO regulations) affect the local fish economy and small-scale fishers.
- Assisting farmers with loan applications and financial planning.
- Working in seafood processing and export firms.
- Developing sustainable management plans for government fisheries departments.
- Specializing in aquatic crop insurance and credit assessment.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | **Introduction to Fisheries Economics**<br>• Definitions and Scope: Basic economic concepts applied to fisheries; the unique nature of fisheries as a common-property resource.<br>• Economic Importance: Contribution of fisheries to the National Economy (GDP), employment generation, and food security.<br>• Micro vs. Macro Economics: Application of supply and demand curves in the seafood market; Price determination of fish and fishery products.<br>• Production Functions: The relationship between fishing effort and catch; Law of Diminishing Returns in fisheries. | **10 Hrs** |

| | | |
|---|---|---|
| II | **Bio-Economic Modeling**<br>• The Gordon-Schaefer Model: Maximum Sustainable Yield (MSY) vs. Maximum Economic Yield (MEY).<br>• Open Access Fisheries: The "Tragedy of the Commons"; Economic consequences of overfishing and overcapitalization.<br>• Economic Optimum: Understanding the point where marginal cost equals marginal revenue in a biological system.<br>**International Trade and Marketing**<br>• Market Structure: Types of fish markets (Retail, Wholesale, Terminal); The role of middlemen and cooperatives.<br>• Export-Import (EXIM): India's position in the global seafood trade; Role of MPEDA (Marine Products Export Development Authority). | **10 Hrs** |
| III | **Fisheries Management and Policy Economics**<br>• Management Tools: Economic impact of quotas (ITQs), taxes, subsidies, and closed seasons.<br>• Socio-Economics: Standard of living of fisherfolk; Role of Microfinance and Self-Help Groups (SHGs) in coastal communities | **10 Hrs** |

## Recommended Textbooks and References


1. Cunningham, S., Dunn, M. R., & Whitmarsh, D. (1985). *Fisheries Economics: An Introduction*. Mansell Publishing. (The classic introductory text).
2. Subba Rao, N. (1986). *Economics of Fisheries*. Deep & Deep Publications. (Highly relevant for the Indian context).
3. Hussen, A. (2004). *Principles of Environmental Economics*. Routledge. (Useful for the Units on externalities and common property).
4. Srivastava, P. K. (1991). *Fishery Development in India*. Deep & Deep Publications.
5. Anderson, L. G., & Seijo, J. C. (2010). *Bioeconomics of Fisheries Management*. Wiley-Blackwell.
6. FAO Fisheries Technical Paper No. 424. *Economic Engineering Applied to the Fishery Industry*.
7. MPEDA Annual Reports. (For current statistics on Indian seafood exports).
8. Handat, K. (2001). *Fisheries Management*. Oxford & IBH.
9. Fish Economy and Fish Biotechnology by Dr. S L Bhalkare , Laxmi book publication, Pune
10.

## SUB/DSC/P/ 376: FISH BIOLOGY

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To train students in using morphometric (measurements) and meristic (counts) features to identify freshwater and marine species.
- To develop skills in the careful dissection of fish to study internal organ systems, including the digestive, reproductive, and respiratory systems.
- To examine specialized structures such as scales, otoliths (ear stones), and gills under magnification for age and health assessment.
- To understand the skeletal framework and the structure of specialized organs like the Weberian apparatus or accessory respiratory organs.
- To learn the methodology of recording length-weight relationships and calculating the condition factor (K) of fish populations.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Independently identify common food and ornamental fishes of India using standard taxonomic keys.
- Demonstrate the ability to expose the brain, heart, and digestive tract of a fish without damaging the specimen.
- Use hard parts like scales or spines to estimate the age of a fish, a critical skill for population management.
- Identify the sex and maturity stage of fish gonads (I to VI) through visual and microscopic examination.
- Perform "Gut Content Analysis" to determine the trophic level (herbivore, carnivore, or omnivore) of a species.
- Students will be capable of producing professional-grade biological reports for environmental impact assessments.
- The skills gained here are foundational for advanced studies in fish genetics, physiology, and pathology.
- Ability to preserve and curate biological specimens using formalin or alcohol for academic collections.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | • Detailed Morphometry: Measurement of total length, standard length, head length, and body depth. Calculation of various body indices.<br>• Meristic Counts: Counting of fin rays (dorsal, anal, pectoral), gill rakers, and lateral line scales.<br>• Scale Study: Microscopic examination of different scale types (Placoid, Cycloid, Ctenoid) and their use in age determination (counting annuli).<br>• Digestive System: Comparative study of the alimentary canal in herbivorous (*Labeo*), carnivorous | **10 Hrs** |

| | | |
|---|---|---|
| | (*Wallago*), and omnivorous fishes.<br>• Respiratory System: Dissection of gills and accessory respiratory organs in *Anabas*, *Clarias*, and *Channa*.<br>• Reproductive System: Observation of male and female gonads; determination of the Gonadosomatic Index (GSI).<br>• Nervous System: Dissection of the brain and cranial nerves; study of the Weberian apparatus in carps. | |
| **II** | • Oxygen Consumption: Measuring the rate of oxygen consumption in a fish using the Winkler method (Respirometer experiment).<br>• Hematology: Preparation of blood smears; identification of RBCs and WBCs; determination of Hemoglobin (Hb) content | **10 Hrs** |
| **III** | • Fecundity Estimation: Calculation of absolute and relative fecundity using the gravimetric method.<br>• Condition Factor (K): Calculation of Ponderal Index or Fulton's condition factor to assess fish health.<br><br>**Project Report :** Students must choose one topic for an independent or group study. The report should follow the standard scientific format: *Introduction, Review of Literature, Materials & Methods, Results, Discussion, and References.*<br>1. Comparative study of the fecundity of two different fish species from a local water body.<br>2. Analysis of the seasonal variation in the GSI (Gonadosomatic Index) of a local fish.<br>3. Survey of fish diversity in a local river, lake, or fish market.<br>4. Study of the length-weight relationship and condition factor of a commercial fish species. | **10 Hrs** |

## Recommended Practical References


1. Srivastava, C. B. L. (2008). *A Manual of Fishery Science*. Kitab Mahal.
2. Khanna, S. S., & Singh, H. R. (2006). *L aboratory Manual of Fish Biology and Fisheries*. Narendra Publishing House.
3. Sakhre V. B, Chalak A.D and Jetithor S.G(2021) Biology of Inland Fishes ,Discovery Publishing House, New Delhi.
4. Lagler, K. F. (1956). *Freshwater Fishery Biology*. W.C. Brown Company.Cailliet, G. M., Love, M. S., & Ebeling, A. W. (1986). *Fishes: A Field and Laboratory Manual on Their Structure, Identification, and Natural History*. Waveland Press.
5. Zar, J. H. (2010). *Biostatistical Analysis*. Pearson Education.
6. Biswas, S. P. (1993). *Manual of Methods in Fish Biology*. South Asia Books.

## SUB/DSC/P/ 377: FISH ECONOMY

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To train students in calculating the fixed and variable costs associated with different aquaculture and capture fishery units.
- To provide hands-on experience in surveying local fish markets to understand price spreads and marketing channels.
- To learn the methodology of conducting interviews and using questionnaires to assess the living standards of fishing communities.
- To develop the ability to prepare a bankable "Detailed Project Report" (DPR) for a start-up venture.
- To trace a fish product from the point of harvest to the final consumer, identifying the "value added" at each stage.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Independently determine the Break-Even Point (BEP) and Payback Period for a fish farm or a fishing vessel.
- Calculate the producer's share in the consumer's rupee and identify the margins taken by middlemen.
- Design and execute a professional survey to analyze the income, debt, and asset distribution of fishers.
- Create a professional financial proposal suitable for submission to banks or NABARD for aquaculture loans.
- Use digital tools (like MPEDA or FAO databases) to interpret export-import trends and price fluctuations.
- Graduates will be equipped to help farmers and entrepreneurs secure funding through technically and financially sound project reports.
- Students will be capable of working with NGOs and Government departments on socio-economic development projects.
- The ability to manage the accounts and marketing strategies for commercial aquaculture estates or seafood processing plants.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | • Market Structure Mapping: Visit to local fish markets (Retail, Wholesale, and Landing Centers) to identify market channels and intermediaries.<br>• Price Trend Analysis: Collection of weekly price data for different fish species (high-value vs. low-value) and plotting seasonal price fluctuations.<br>• Consumer Preference Study: Designing and conducting a survey to understand consumer behavior regarding fresh vs. processed fish.<br>• Cost-Benefit Analysis (CBA): Preparation of a balance | 10 Hrs |

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| | sheet for a 1-hectare aquaculture farm (fixed costs vs. operational costs).<br>• Profitability Indices: Calculation of Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit-Cost Ratio (BCR) for a proposed fisheries project. | |
| **II** | • Livelihood Assessment: Use of Participatory Rural Appraisal (PRA) tools to study the socio-economic status of a fishing community.<br>• Gender Roles: Documenting the contribution of women in post-harvest activities and dry fish marketing. | **10 Hrs** |
| **III** | • Export Procedures: Case study of the documentation required for seafood export (Invoice, Packing List, Bill of Lading, Health Certificate).<br>• Quality Economics: Analyzing the cost-impact of maintaining HACCP and EU standards on the final export price.<br>**Project report:** Students are required to submit a comprehensive **Project Report** based on field data. The project should focus on a "Techno-Economic Feasibility Study."<br>1. Economic Analysis of a Specific Culture System: (e.g., "Economics of Biofloc Tilapia Farming in [Region]").<br>2. Cooperative Societies: (e.g., "Performance Evaluation of a Primary Fishermen Cooperative Society" | **10 Hrs** |

## Recommended Practical References


1. FAO Fisheries Technical Paper No. 424. *Economic Engineering Applied to the Fishery Industry*. (Excellent for cost-benefit calculations).
2. Shang, Y. C. (1990). *Aquaculture Economic Analysis*. World Aquaculture Society. (The best manual for farm-level economics).
3. Subba Rao, N. (1986). *Economics of Fisheries*. Deep & Deep Publications.
4. MPEDA Manuals. *Export Procedures and Documentation for Seafood*. Marine Products Export Development Authority.
5. Panda, S. C. (2011). *Farm Management and Agricultural Marketing*. Kalyani Publishers.
6. Tietze, U. et al. (2001). *Techno-economic Performance of Marine Capture Fisheries*. FAO Fisheries Technical Paper.
7. Fish Economy and Fish Biotechnology by Dr. S L Bhalkare , Laxmi book publication, Pune

**SUB/DSC/T/ 352: IKS- 2 INDIAN KNOWLEDGE SYSTEM RELATED TO MAJOR)**

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To explore the "Matsya" (Fish) in Indian cosmology and the early observations of fish behavior and diversity in ancient texts.
- To study the classification of fishes as described in the *Manasollasa* (12th Century) and *Sushruta Samhita*, comparing them with modern biological categories.
- To understand ancient Indian methods of pond construction, water purification using natural coagulants, and sustainable harvesting practices.
- To analyze the principles of the "Blue Economy" in ancient India, including state-regulated fisheries, trade guilds (*Shrenis*), and taxation as outlined in the *Arthashastra*.
- To document the traditional wisdom of indigenous fishing communities regarding lunar cycles, seasonal migration, and plant-based fish management.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Identify and explain references to fish anatomy, breeding, and habitat management in Sanskrit and regional historical literature.
- Evaluate the sustainability of ancient water harvesting structures (e.g., *Pushkarnis* and stepwells) and their relevance to modern aquaculture.
- Discuss the concept of "Matsya Nyaya" (the fundamental law of nature) and its relation to modern ecological balance and predator-prey dynamics.
- Explain how ancient India managed fish as a commodity, including the logistics of dried fish trade and the socio-economic status of the *Nishada* (fisher) communities.
- Propose methods to incorporate traditional knowledge into modern fishery management plans to promote eco-friendly and culturally resonant practices.
- Graduates will possess a unique perspective on the evolution of science in India, fulfilling the requirements of **NEP-2020**.
- Students will be prepared for research roles that combine Indology, History, and Fishery Science.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | **Ancient Literature and Ichthyology**<br>• Fish in Vedic and Post-Vedic Literature: References to fish in the *Rig Veda*, *Arthashastra*, and *Puranas*; Symbolism of *Matsya Avatara*.<br>• Indigenous Taxonomy: Ancient Indian systems of naming and identifying fish based on morphological traits, behavior, and medicinal properties. | **10 Hrs** |

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| **II** | **Indigenous Technical Knowledge (ITK) in Fish Capture**<br>• Traditional Gear and Craft: Engineering principles behind the *Coracle*, *Catamaran*, and *Masula* boats; Use of natural fibers (coir, cotton, hemp) in net making.<br>• Eco-friendly Harvest: Techniques like *Vellavali* (scaring fish with coconut leaves), bamboo traps (*Gada*, *Polo*), and the use of herbal piscicides (e.g., *Mahuwa* oil cake).<br>• Lunar and Astral Links: Traditional calendars used by coastal fishers to predict tides, currents, and fish shoals (*Nakshatra*-based fishing).<br><br>**Ancient Aquaculture and Water Management**<br>• Traditional Farming Systems:<br>➢ Pokkali (Kerala): Integrated shrimp-and-salt-tolerant-paddy farming.<br>➢ Bheries (West Bengal): Traditional brackishwater impoundments.<br><br>• Ancient Irrigation and Fisheries | **10 Hrs** |
| **III** | **Historical Fish Economy and Governance**<br>• The Arthashastra Perspective: Kautilya's guidelines on state-owned fisheries.<br>• Traditional Processing: Ancient methods of sun-drying, pickling, and the production of *Masmin* (Lakshadweep).<br>• Trade Routes: Historical seafood trade between India and the Roman/Arab worlds. | **10 Hrs** |

## Recommended Textbooks and References


1. Sadhale, N. (2012). *Manasollasa (Book 3 - Vimsati 4): Fish and Fishing*. Asian Agri-History Foundation. (The primary source for ancient Indian fish biology).
2. Srivastava, P. K. (1991). *Fishery Development in India*. Deep & Deep Publications. (Contains chapters on historical evolution).
3. Kapoor, S. (2002). *The Indian Encyclopedia: Indic Studies*. Cosmo Publications.
4. Horner, I. B. (1975). *Fishes in the Pali Canon*. Journal of the Royal Asiatic Society.
5. Nene, Y. L. (2005). *Agricultural Heritage of India*. Asian Agri-History Foundation.
6. Sundaresh, A. S. (1993). *Traditional Fishing Crafts of India*. National Institute of Oceanography.
7. Siddhartha, G. (2021). *The Blue Economy: An Indian Perspective*. (For modern links to ancient systems).
8. Vikas, P. A., et al. (2018). *Traditional Knowledge in Fisheries*. CMFRI Special Publication.

**SUB/DSC/P/ 376: IKS- 2 INDIAN KNOWLEDGE SYSTEM RELATED TO MAJOR)**

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To train students in recording local and traditional names of fish species and comparing them with classifications found in texts like the *Manasollasa*.
- To study the design and functionality of ancient Indian water harvesting structures (Stepwells, *Pushkarnis*, and temple tanks) for fish rearing.
- To evaluate the scientific basis of traditional water purification methods (e.g., using *Nirmali* seeds or Amla wood) and plant-based fish stupefacients.
- To map historical fish trade centers and understand the socio-economic structure of traditional fishing guilds (*Shrenis*).
- To provide hands-on experience in the fabrication and operation of indigenous bamboo traps, nets, and artisanal crafts.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Scientifically test and verify the efficacy of ancient Indian herbal additives in pond soil and water management.
- Conduct professional ethno-biological interviews with elder members of fishing communities to document vanishing traditional ecological knowledge (TEK).
- Create comparative charts between ancient Indian "Matsya" categories and modern biological families.
- Prepare detailed documentation of local indigenous fishing crafts and gear, including their material composition and seasonal use.
- Design a conceptual fish pond layout based on traditional Indian architectural principles (Vastu Shastra) for optimized water flow and energy.
- Students will be equipped to work on projects involving the conservation of India's aquatic cultural heritage.
- Ability to offer low-cost, eco-friendly alternatives for water management based on verified IKS principles.
- Graduates will be prepared to contribute to the development of IKS-based educational modules for schools and colleges.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | • Anatomical Observations in IKS: Identification of fish organs mentioned in ancient texts (e.g., *pitta* for gall bladder, *akshi* for eyes) through dissection.<br>• Model Making: Construction of miniature models of traditional Indian crafts (*Coracle*, *Catamaran*, *Kettuvallam*).<br>• Natural Fiber Technology: Testing the tensile strength and durability of traditional net materials (cotton, coir, sunn-hemp) vs. synthetic fibers. | **10 Hrs** |

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| | • Trap Fabrication: Constructing traditional bamboo traps (*Polo*, *Gada*, or *Tapi*) and analyzing their selective harvesting efficiency | |
| **II** | • Sacred Grove/Tank Ecology: Ecological survey of a temple tank to study protected fish biodiversity and traditional water management.<br>• Herbal Piscicides & Repellents: Testing the efficacy of plant-based piscicides (e.g., *Mahuwa* oil cake or *Croton* seeds) and their recovery time for fish. | **10 Hrs** |
| **III** | **Project Work:**<br>"Virasat" (Heritage) Report: Each student must submit a report on an **Indigenous Fishery Practice** of their home region, including:<br>1. Scientific rationale behind the practice.<br>2. Sustainability assessment.<br>3. Photographic/Illustrative documentation. | **10 Hrs** |

## Recommended Practical References


1. Sadhale, N. (2012). *Manasollasa (Book 3 - Vimsati 4): Fish and Fishing*. Asian Agri-History Foundation. (Essential for replicating ancient experiments).
2. Vikas, P. A., et al. (2018). *Traditional Knowledge in Fisheries*. CMFRI Special Publication. (A guide to documenting ITKs).
3. Sundaresh, A. S. (1993). *Traditional Fishing Crafts of India*. National Institute of Oceanography.
4. Horner, I. B. (1975). *Fishes in the Pali Canon*. Journal of the Royal Asiatic Society.
5. CIFT Manual. *Traditional Fishing Gear and Crafts of India*. ICAR-Central Institute of Fisheries Technology.
6. Nene, Y. L. (2005). *Agricultural Heritage of India*. Asian Agri-History Foundation.
7. Siddhartha, G. (2021). *The Blue Economy: An Indian Perspective*.

**SUB/DSE/T/ 350: ECOLOGY AND RESOURCE MANAGEMENT**

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To study the structure and function of freshwater, estuarine, and marine ecosystems, including energy flow and food webs.
- To analyze how environmental factors like temperature, light, salinity, and dissolved gases influence aquatic life and productivity.
- To understand the dynamics of fish populations, including recruitment, growth, mortality, and the concept of "Maximum Sustainable Yield" (MSY).
- To identify endangered aquatic species and study the impact of invasive species, habitat destruction, and pollution on aquatic health.
- To learn the methods of estimating fish stocks in open water bodies like rivers, lakes, and reservoirs.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Evaluate the trophic status of a water body (Oligotrophic vs. Eutrophic) based on biological and chemical indicators.
- Apply seasonal fishing bans, mesh size regulations, and sanctuary creation to protect breeding populations.
- Determine the effects of domestic, industrial, and agricultural effluents on aquatic biodiversity and suggest mitigation measures.
- Use mathematical models to predict fish stock recovery and determine safe harvesting limits to prevent stock collapse.
- Formulate conservation plans for wetlands and coral reefs, integrating community-based management and international environmental laws.
- Protecting endangered aquatic flora and fauna.
- Setting policies for riverine and marine fishing seasons.
- Conducting Environmental Impact Assessments (EIA) for river valley projects.
- Studying the impact of global warming on fish migration and distribution.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | **Fundamentals of Aquatic Ecology**<br>• Concepts of Ecology: Ecosystem structure and function; Biotic and abiotic components of aquatic ecosystems.<br>• Energy Flow: Food chains, food webs, and trophic levels in aquatic environments; Ecological pyramids (Energy, Biomass, Numbers).<br>• Nutrient Cycling: Detailed study of Carbon, Nitrogen, and Phosphorus cycles in freshwater and marine systems.<br>• Biogeochemical Zones: Classification of aquatic environments (Lentic vs. Lotic; Pelagic, Benthic, | **10 Hrs** |

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| | Estuarine, and Mangrove ecosystems).<br>**Population Dynamics**<br>• Population Characteristics: Density, natality, mortality, age structure, and sex ratio.<br>• Growth Models: Exponential and Logistic growth curves; Carrying capacity (K).<br>• Recruitment: Factors affecting recruitment; Spawner-Recruit relationships (Beverton-Holt and Ricker models).<br>• Mortality: Estimation of Natural Mortality (M) and Fishing Mortality (F); Total Mortality (Z) | |
| **II** | **Fisheries Resource Assessment**<br>• Stock Concept: Definition of fish stocks and unit stocks; Methods of stock identification (Morphometrics, Tagging, Genetic markers).<br>• Data Collection: Catch and Effort data; CPUE (Catch Per Unit Effort) as an index of abundance.<br>• Stock Assessment Models:<br>➢ Surplus Production Models: Schaefer and Fox models.<br>➢ Analytical Models: Yield-per-recruit model (Beverton and Holt).<br>➢ Virtual Population Analysis (VPA): Principles and application<br>**Aquatic Pollution and Environmental Management**<br>• Pollution Sources: Industrial effluents, agricultural runoff (eutrophication), and plastic pollution.<br>• Impact on Fisheries: Bioaccumulation and Biomagnifications of heavy metals and pesticides.<br>• Climate Change: Impact of global warming, ocean acidification, and sea-level rise on fish distributions and coral reefs.<br>• Conservation: Endangered aquatic species; IUCN Red List categories; In-situ and Ex-situ conservation. | **10 Hrs** |
| **III** | **Resource Management and Policy**<br>• Management Objectives: Biological (MSY), Economic (MEY), and Social objectives.<br>• Protected Areas: Marine Protected Areas (MPAs) and Fish Sanctuaries.<br>• International Agreements: UNCLOS, FAO Code of Conduct for Responsible Fisheries (CCRF). | **10 Hrs** |

## Recommended Textbooks and References


1. Odum, E. P. (1971). *Fundamentals of Ecology*. W.B. Saunders Co. (The foundational text for general ecology).
2. Gulland, J. A. (1983). *Fish Stock Assessment: A Manual of Basic Methods*. FAO/Wiley Series.
3. Sparre, P., & Venema, S. C. (1998). *Introduction to Tropical Fish Stock Assessment*. FAO Fisheries Technical Paper No. 306.
4. Tait, R. V., & Dipper, F. (1998). *Elements of Marine Ecology*. Butterworth-Heinemann.
5. Cushing, D. H. (1981). *Fisheries Biology: A Study in Population Dynamics*. University of Wisconsin Press.
6. Welch, E. B. (1992). *Ecological Effects of Waste Water*. Chapman & Hall.
7. King, M. (2007). *Fisheries Biology, Assessment and Management*. Blackwell Publishing.
8. FAO. *Code of Conduct for Responsible Fisheries*. (Essential for management policy units).

## SUB/DSE/T/ 351: ENGINEERING AND POST-HARVEST TECHNOLOGY

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To study the principles of site selection, pond construction, and the design of specialized structures like hatcheries, raceways, and Recirculating Aquaculture Systems (RAS).
- To understand the mechanics of pumps, aerators, and filtration systems essential for maintaining high-intensity culture environments.
- To study the post-mortem changes in fish (rigor mortis, autolysis, and spoilage) and the factors affecting the quality of fish as a perishable commodity.
- To explore the thermal and non-thermal methods of preservation, including icing, freezing, canning, smoking, and irradiation.
- To learn the technology behind creating processed fish products and the utilization of fish waste for high-value by-products like fish meal, oil, and chitin.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Design and supervise the construction of fish ponds and hatcheries, ensuring proper dyke stability and water flow.
- Implement effective "Chill Chain" and "Cold Chain" logistics to ensure fish reach consumers in prime condition.
- Identify the stages of fish spoilage using sensory and biochemical indicators to ensure food safety.
- Understand the working principles of industrial machinery like plate freezers, blast freezers, and canning retorts.
- Apply modern packaging and preservation technologies to extend the shelf life of seafood, thereby increasing the economic return for fishers and farmers.
- Designing and building large-scale commercial fish farms.
- Overseeing operations in export-oriented seafood units.
- Ensuring products meet international safety standards (HACCP, ISO).
- Developing and marketing value-added fish products like fillets, pickles, and ready-to-eat meals.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | **Fundamentals of Fishery Engineering**<br>• Site Selection and Surveying: Engineering properties of soil; leveling and contouring for farm construction.<br>• Pond Construction: Design and layout of different types of ponds (nursery, rearing, stocking); calculation of earthwork; types of dikes and sluice gates.<br>• Hatchery Engineering: Design and construction of Chinese circular hatcheries, jar hatcheries, and water filtration systems. | **10 Hrs** |

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| | **Fishing Craft and Gear Technology**<br>• Fishing Crafts: Classification and evolution of fishing boats; materials used for boat building (wood, FRP, steel, aluminum); maintenance of fishing vessels.<br>• Fishing Gears: Classification of gears (trawls, gill nets, long lines, traps); properties of fishing gear materials (natural and synthetic fibers); net making and mending techniques | |
| **II** | **Fish Preservation and Processing**<br>• Chilling and Icing: Physical properties of ice; types of ice (flake, tube, block); icing techniques and sea-water chilling.<br>• Freezing: Principles of freezing; types of freezers (plate, blast, cryogenic); glazing and packaging of frozen products.<br>• Drying and Curing: Principles of sun drying and mechanical drying; salting methods (dry, wet, and pit curing); smoking of fish.<br>• Canning: Principles of thermal processing; canning procedure for fish and shellfish; common defects in canned products. | **10 Hrs** |
| **III** | **Value Addition and By-Products**<br>• Value-Added Products: Preparation of surimi, fish mince, breaded and battered products (fish fingers, cutlets).<br>• Fishery By-Products: Production of fish meal, fish oil, fish protein concentrate (FPC), fish silage, and shark fin rays. | **10 Hrs** |

**Recommended Textbooks and References**


1. Wheaton, F. W. (1993). *Aquacultural Engineering*. John Wiley & Sons.
2. Balachandran, K. K. (2001). *Post-harvest Technology of Fish and Fish Products*. Daya Publishing House.
3. Gopakumar, K. (2002). *Textbook of Fish Processing Technology*. ICAR, New Delhi.
4. Srivastava, P. K. (1991). *Fishery Science and Indian Fisheries*. Kitab Mahal.
5. Hall, G. M. (1997). *Fish Processing Technology*. Blackie Academic & Professional.
6. Sainsbury, J. C. (1996). *Commercial Fishing Methods: An Introduction to Vessels and Gears*. Fishing News Books.
7. Huss, H. H. (1995). *Quality and Quality Changes in Fresh Fish*. FAO Fisheries Technical Paper No. 348.
8. ICAR-CIFT. *Manual on Fish Processing Technology*. Central Institute of Fisheries Technology, Kochi.


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**SUB/DSE/P/ 376: ECOLOGY AND RESOURCE MANAGEMENT**

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To train students in the scientific collection of water, soil, and biological samples from different aquatic habitats (Rivers, Ponds, Reservoirs).
- To provide hands-on experience in measuring "Life-Supporting" factors like Dissolved Oxygen, pH, Alkalinity, and Hardness.
- To teach methods of estimating primary productivity (Light and Dark bottle method) and the quantitative analysis of plankton and benthos.
- To introduce the practical methods of estimating fish populations, including the "Mark and Recapture" technique and Length-Frequency analysis.
- To identify and quantify indicators of aquatic pollution and study the impact of environmental stressors on fish health.

**Course Outcomes ( COs) :**
Upon successful completion of this paper, students will be able to:

- Independently perform a "Health Audit" of a water body and classify it based on its nutrient status (Eutrophic, Mesotrophic, or Oligotrophic).
- Competently use Secchi discs (for transparency), Ekman dredges (for bottom soil), and plankton nets.
- Use Length-Weight data to calculate the "Relative Condition Factor" and assess if a fish population is thriving or overexploited.
- Identify and categorize aquatic macrophytes, insects, and fish species to determine the biodiversity index of a region.
- Suggest scientifically-backed measures such as closed seasons or mesh-size regulations based on field data.
- Graduates will be proficient in monitoring water quality for government pollution control boards.
- Students will have the foundational skills to assist in large-scale fish stock assessments for national fisheries institutes.
- Ability to provide biological data for Environmental Impact Assessment reports required for infrastructure projects near water bodies.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | • Estimation of Primary Productivity: Practical determination of Gross Primary Productivity (GPP) and Net Primary Productivity (NPP) using the Light and Dark Bottle method.<br>• Planktonology:<br>➢ Collection and preservation of phyto- and zooplankton using plankton nets.<br>➢ Quantitative estimation using a Sedgewick-Rafter counting cell.<br>➢ Identification of indicator species for organic pollution. | **10 Hrs** |

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| II | • Habitat Mapping: Using GPS (Global Positioning System) to map a local water body or mangrove area.<br>• Bioassay Tests: Determination of LC_50 (Lethal Concentration) of a heavy metal or pesticide on a model fish species (e.g., Guppy or Zebra fish) over 96 hours. | **10 Hrs** |
| III | **Project & Field Exposure:**<br>• Visit to a Fish Landing Center: Collection of catch and effort data for a specific gear type.<br>• Visit to a Protected Area: Observational study of a Fish Sanctuary or Marine Protected Area (MPA).<br>• Project Report: Preparation of a "Status of Local Fishery Resources" report based on primary field data | **10 Hrs** |

## Recomended Practical References


1. Sparre, P., & Venema, S. C. (1998). *Introduction to Tropical Fish Stock Assessment - Part 1: Manual*. FAO Fisheries Technical Paper No. 306/1. (The "Bible" for fisheries stock assessment).
2. APHA (2017). *Standard Methods for the Examination of Water and Wastewater*. American Public Health Association. (Standard for chemical analysis).
3. Michael, P. (1984). *Ecological Methods for Field and Laboratory Investigations*. Tata McGraw-Hill.
4. Biswas, S. P. (1993). *Manual of Methods in Fish Biology*. South Asia Books.
5. King, M. (2007). *Fisheries Biology, Assessment and Management*. Blackwell Publishing.
6. Gulland, J. A. (1983). *Fish Stock Assessment: A Manual of Basic Methods*. FAO/Wiley Series.
7. Wetzel, R. G., & Likens, G. E. (2000). *Limnological Analyses*. Springer.

**SUB/DSE/P/ 377: ENGINEERING AND POST-HARVEST TECHNOLOGY**

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To train students in using surveying instruments (Levels, Theodolites, or GPS) for selecting and marking sites for pond construction.
- To provide hands-on experience in drafting blueprints for fish farms, including the calculation of earthwork and the design of sluice gates.
- To demonstrate the scientific principles of fish icing, freezing, drying, and salting to extend shelf life.
- To teach the methods of organoleptic (sensory) and chemical assessment of fish freshness and quality.
- To provide practical training in the preparation of fish-based products such as pickles, wafers, and fillets.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Design a functional aquaculture farm with appropriate water supply and drainage systems based on topographical data.
- Safely use and maintain post-harvest machinery like vacuum packaging machines, deep freezers, and solar dryers.
- Quantitatively and qualitatively evaluate the freshness of fish using the Sensory Evaluation Method and biochemical tests.
- Independently process raw fish into high-market-value products, reducing post-harvest losses.
- Calculate the exact ice-to-fish ratio required for long-distance transportation to maintain the cold chain.
- Students will be ready to supervise the construction of new aquaculture projects and hatcheries.
- Graduates will be equipped to work in seafood processing plants ensuring compliance with safety standards.
- Ability to innovate and develop new fish-based snack foods for the retail market.
- Expertise in managing the logistics of fish transportation from landing centers to urban markets.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | • Hatchery Layout: Preparation of a blue-print for a Chinese circular hatchery or a portable FRP hatchery.<br>• Net Mending: Hands-on training in repairing torn fishing nets (cutting, lacing, and knotting).<br>• Net Making: Construction of a miniature gill net or a cast net; calculation of mesh size and hanging coefficient.<br>• | 10 Hrs |

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| **II** | • Sensory Evaluation: Assessing the freshness of fish using the Quality Index Method (QIM) (Eyes, Gills, Skin, and Odor).<br>• Chemical Analysis: Estimation of Total Volatile Base Nitrogen (TVB-N) and Trimethylamine (TMA).<br>➢ Determination of Peroxide Value (PV) and Free Fatty Acids (FFA) in fish oils to detect rancidity.<br>• Microbiological Quality: Estimation of the Total Plate Count (TPC) of fresh and frozen fish samples.<br>➢ Chilling and Freezing: Comparison of cooling rates using flake ice vs. crushed block ice.<br>➢ Calculation of Drip Loss in frozen-thawed fish fillets.<br>➢ Curing and Drying: Preparation of salted fish (Dry and Wet Salting).<br>➢ Monitoring moisture loss and calculating the rehydration ratio of dried fish.<br>➢ Canning Lab: Can seaming operations and Double Seam Analysis (measuring overlap and seam thickness).<br>➢ Heat penetration study in a laboratory-scale retort. | **10 Hrs** |
| **III** | • Product Preparation: Extraction of fish mince using a meat bone separator.<br>➢ Preparation of breaded products (Fish fingers, cutlets) and Fish Pickles.<br>• By-Product Extraction: Production of fish meal and fish oil at a laboratory scale.<br>➢ Extraction of Chitin and Chitosan from prawn shell waste. | **10 Hrs** |

**Recommended Practical References**


1. CIFT Manual (2014). *Manual on Fish Processing Technology*. ICAR-Central Institute of Fisheries Technology, Kochi. (Standard for Indian labs).
2. AOAC International (2016). *Official Methods of Analysis*. (For chemical indices like TVB-N and PV).
3. Wheaton, F. W. (1993). *Aquacultural Engineering*. John Wiley & Sons. (For farm construction practicals).
4. Sainsbury, J. C. (1996). *Commercial Fishing Methods: An Introduction to Vessels and Gears*. Fishing News Books.
5. Balachandran, K. K. (2001). *Post-harvest Technology of Fish and Fish Products*. Daya Publishing House.
6. FAO Training Series. *Simple Methods for Aquaculture: Pond Construction*. (Visual guide for surveying and earthwork).
7. Lars Herborg (1991). *Manual on Fish Canning*. FAO Fisheries Technical Paper.

**SUB/Mn/T/350: ADVANCED MULTI-TROPHIC AND CIRCULAR ECOSYSTEM**

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To understand the core ecological principles behind shift from traditional aquaculture monoculture to sustainable, multi-species circular systems.
- To understand the scientific dynamics of nutrient partitioning, mass balance, and energy flow across different trophic levels (fed, organic extractive, and inorganic extractive components).
- To acquire engineering and conceptual design knowledge for setting up both open-water marine IMTA systems and advanced land-based loop technologies (RAS, Biofloc, and Decoupled Aquaponics).
- To evaluate the bio-economic viability, life cycle sustainability, and ecosystem services provided by waste-to-resource circular designs.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Analyze nutrient flow pathways and execute mass-balance calculations to mitigate environmental eutrophication in aquatic designs.
- Design a functional multi-trophic layout pairing fed species with appropriate organic (filter-feeders) and inorganic (seaweeds) extractive counterweights.
- Manipulate carbon-to-nitrogen (C:N) ratios in heterotrophic ecosystems to optimize biofloc performance and bacterial protein conversion.
- Evaluate the sustainability of a circular aquaculture enterprise using Life Cycle Assessment (LCA) metrics and carbon accounting frameworks.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | **Foundations of Integrated Multi-Trophic Aquaculture (IMTA):**<br>• Concept and Philosophy: Principles of IMTA; transition from monoculture to balanced multi-species ecosystems; ecological niche segregation.<br>• Trophic Level Dynamics: Functional roles of fed components (fishes/shrimps), extractive inorganic components (seaweeds/macrophytes), and extractive organic components (mollusks/benthic detritivores).<br>• Mass Balance and Energy Flow: Nutrient recycling pathways; reducing nitrogen (N) and phosphorus (P) footprints in open-water and land-based systems.<br>• Mass Balance Principles: Quantifying nutrient pathways; mitigating environmental eutrophication through closed-loop bioconversion. | **10 Hrs** |

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| II | **Open-Water and Marine IMTA Engineering:**<br>• Coastal Grid Design: Spatial zoning and layout of near-shore multi-trophic clusters combining finfish sea-cages with seaweed and shellfish longlines.<br>• Benthic Extractive Loops: The role of deposit-feeders (e.g., sea cucumbers, sea urchins) beneath aquaculture cages for consuming heavy particulate settlement and fecal matter.<br>• Environmental Hydrodynamics: Assessing water current velocity, dilution rates, and local biological carrying capacity to optimize extractive recycling efficiency. | **10 Hrs** |
| III | **Bio-Economics, Policy, and Sustainability Metrics**<br>• Life Cycle Assessment (LCA): Measuring environmental impacts, carbon accounting, and water-use efficiency in circular systems.<br>• Bio-Economic Valuation: Valuation of ecosystem services (e.g., carbon sequestration by seaweeds, biological filtration by oysters).<br>• Global Frameworks: Alignment with the UN Sustainable Development Goals (SDGs) and international regulations on ecological aquaculture. | **10 Hrs** |

**RECOMMENDED TEXTBOOKS AND REFERENCES**


1. Chopin, T., & Robinson, S. (Eds.). (2020). *Integrated Multi-Trophic Aquaculture (IMTA): Realizing the Promise of Ecological Aquaculture*. Springer. *(Covers the structural essentials of Units 1 and 2).*
2. Avnimelech, Y. (2015). *Biofloc Technology: A Practical Guide Book*. World Aquaculture Society. *(The definitive guide for Unit 3's heterotrophic loop mechanics).*
3. Timmons, M. B., & Ebeling, J. M. (2013). *Recirculating Aquaculture Systems*. Cayuga Aqua Ventures. *(Essential for modern land-based engineering and multi-loop configurations).*
4. Soto, D. (Ed.). (2009). *Integrated Mariculture: A Global Review*. FAO Fisheries and Aquaculture Technical Paper No. 529. FAO, Rome.
5. Somerville, C., et al. (2014). *Small-scale Aquaponic Food Production*. FAO Fisheries and Aquaculture Technical Paper No. 589. FAO, Rome.

## SUB/Mn/T/351: SOCIO-ECONOMICS AND RURAL LIVE HOODS

Total Credits : 02 | Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To understand the core sociological structures, demography, and occupational frameworks of fishing and rural farming communities.
- To learn the mechanics of the Sustainable Livelihoods Framework (SLF) and learn to assess rural vulnerability vectors.
- To evaluate institutional vs. non-institutional rural credit options and understand how to disrupt the cycle of rural indebtedness.
- To analyze the structural impacts of major national development schemes (like PMMSY, MGNREGA, and NRLM) on rural wealth generation.
- To formulate gender-mainstreamed, community-led co-management policies using Participatory Rural Appraisal (PRA) techniques.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Examine and Profile rural social systems to pinpoint vulnerabilities linked to seasonal patterns, migration, or market volatility.
- Deploy and Map the DFID Asset Pentagon to measure community resilience and design micro-enterprise diversification loops.
- Evaluate and Propose credit-delivery adjustments or cooperative self-help frameworks (SHGs) to minimize dependence on informal debt.
- Formulate community-based asset development strategies that integrate government schemes and gender-inclusive policies.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | **Foundations of Rural Socio-Economics**<br>• Concepts and Definitions: Definition, scope, and importance of rural socio-economics in primary sectors (fisheries and agriculture).<br>• Social Structure of Rural Communities: Social stratification, caste dynamics, kinship networks, and leadership patterns in traditional fishing and farming villages.<br>• Economic Demography: Demography of coastal and inland fishing communities; literacy rates, occupational shifts, and seasonal migration patterns.<br>**Livelihood Frameworks and Security**<br>• The Sustainable Livelihoods Framework (SLF): Understanding the DFID model—Vulnerability context, Livelihood Assets (Natural, Physical, Human, Financial, Social capital), Transforming Structures, and Livelihood Outcomes.<br>• Vulnerability and Risk Management: Vulnerability of fishers and farmers to climate change, monsoonal bans, market failures, and natural disasters; traditional | **10 Hrs** |

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| | vs. modern coping mechanisms.<br>• Diversification: Strategies for micro-enterprise development; supplementary livelihoods (e.g., seaweed farming, ornamental fish rearing, value-added food processing). | |
| **II** | **Institutional Support and Rural Credit Systems**<br>• Rural Finance: Sources of credit—Institutional (NABARD, Commercial Banks, Regional Rural Banks) vs. Non-institutional (local money lenders, middle-men); the vicious cycle of rural indebtedness.<br>• Micro-finance and Self-Help Groups (SHGs): Role of SHGs, micro-credit institutions, and cooperative credit societies in empowering rural women and small-scale operations.<br>• Cooperative Movements: Structure and functioning of functional cooperative models (e.g., Primary Fishermen Cooperative Societies, dairy cooperatives like AMUL as templates). | **10 Hrs** |
| **III** | **Public Policy, Governance, and Development Schemes**<br>• Rural Development Programs: Critical appraisal of landmark schemes—MGNREGA (employment guarantee), PMMSY (Pradhan Mantri Matsya Sampada Yojana), and NRLM (National Rural Livelihoods Mission).<br>• Common Property Resources (CPRs): Management of open-access waters, community pastures, and forests; Co-management strategies and Participatory Rural Appraisal (PRA) principles.<br>• Gender and Development: Gender division of labor in fisheries (men in harvest, women in post-harvest/marketing); policies addressing gender mainstreaming and property rights. | **10 Hrs** |

**RECOMMENDED TEXTBOOKS AND REFERENCES**


1. Chambers, R. (1983). *Rural Development: Putting the Last First*. Longman. *(The foundational text for understanding rural livelihoods and vulnerability).*
2. Subba Rao, N. (1986). *Economics of Fisheries*. Deep & Deep Publications. *(Crucial for the Indian fisheries socioeconomic framework).*
3. Ray, G. L. (2015). *Extension Communication and Management*. Kalyani Publishers. *(Excellent for rural structural dynamics).*
4. Katar Singh (2009). *Rural Development: Principles, Policies and Management*. SAGE Publications.
5. FAO Fisheries Technical Paper No. 477. *Human Rights and Poverty Reduction in Shallow-water Fisheries*. FAO, Rome.
6. Sathiadhas, R. (2009). *Socio-Economic Dimensions of Marine Fisheries in India*. CMFRI Publication.
7. DFID (1999). *Sustainable Livelihoods Guidance Sheets*. Department for International Development.
8. Ministry of Rural Development, GoI. *Annual Reports and Operational Guidelines for NRLM and MGNREGA*.

## SUB/DSE/P/376 : FISHERY ECONOMICS AND EXTENSION

Total Credits : 02

Total Contact Hours : 30 Hrs
Maximum Marks : 50

**Learning Objectives of the Course:**

- To train students in calculating the economic indicators of a fish farm, such as the Internal Rate of Return (IRR) and the Payback Period.
- To provide hands-on experience in visiting wholesale and retail fish markets to understand the supply chain and price fluctuations.
- To teach the creation of effective communication materials, including posters, folders, and digital presentations for rural audiences.
- To learn how to conduct interviews and use Participatory Rural Appraisal (PRA) techniques to understand the needs of fishing communities.
- To develop the ability to prepare a bankable "Detailed Project Report" (DPR) for securing institutional credit and government subsidies.

**Course Outcomes ( COs) :**

Upon successful completion of this paper, students will be able to:

- Independently determine the **Break-Even Point (BEP)** and evaluate the financial health of an aquaculture venture.
- Calculate the producer's share in the consumer's rupee and identify the marketing margins taken by various intermediaries.
- Demonstrate the ability to conduct a "Result Demonstration" or a "Method Demonstration" for a group of fishers.
- Guide farmers through the process of applying for KCC (Kisan Credit Cards) and other fisheries-related insurance and loans.
- Design and execute survey questionnaires to collect data on the standard of living, debt, and educational status of coastal or inland fishers.
- Graduates will be capable of leading "Lab-to-Land" programs for government departments or NGOs.
- Ability to help entrepreneurs design and fund large-scale aquaculture projects.
- Skillset to work in the marketing and logistics departments of seafood export companies.
- Capacity to work on socio-economic upliftment and policy advocacy for marginalized fishing communities.

| Module | Topics / actual contents of the syllabus | Contact Hours |
|---|---|---|
| I | • Collection of retail and wholesale prices of major fish species to calculate the marketing margin and "Producer's Share in Consumer's Rupee."<br>• Preparation of a hypothetical business plan for a 1-acre aquaculture farm, including Fixed Costs (pond construction, equipment) and Variable Costs (seed, feed, labor).<br>• Calculation of Net Present Value (NPV) and Benefit-Cost Ratio (BCR) to determine the long-term viability | **10 Hrs** |

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|---|---|---|
| | of a fishery project.<br>• Participation in Seminars/Ratio Talk/Poster/Leaflets/Flyers & Extension activities. | |
| **II** | • Demonstration Techniques: Organizing and conducting a "Method Demonstration" (e.g., how to use a pH meter or how to prepare a fish feed premix).<br>• Audio-Visual Aids: Handling and use of LCD projectors, public address systems, and the use of mobile apps for fisheries extension.<br>• Socio-Economic Survey: Designing a questionnaire and conducting interviews in a fishing village to assess living standards, education, and household income.<br>• Participatory Rural Appraisal (PRA): Exercise in Social Mapping and Transect Walks to understand the resources and constraints of a fishing community.<br>• Leadership Identification: Using sociometry techniques to identify formal and informal leaders in a coastal or inland village. | **10 Hrs** |
| **III** | **Project Report & Field Visits**<br>• Field visit to a local fish landing center or wholesale market to identify the roles of "Aratdars" (wholesalers), brokers, and retailers.<br>• Visit to a Cooperative Society: Studying the organizational structure and benefit-sharing model of a Primary Fishermen Cooperative Society.<br>• Visit to a KVK/Extension Center: Understanding how scientists transfer laboratory research to the farmers' fields.<br>• Case Study: Preparation of a detailed project report on the "Economic Impact of a New Fishing Technology" in a specific region. | **10 Hrs** |

## Recommended Practical References


1. Shang, Y. C. (1990). *Aquaculture Economic Analysis*. World Aquaculture Society. (The most comprehensive manual for aquaculture financial modeling).
2. Ray, G. L. (2015). *Extension Communication and Management*. Kalyani Publishers. (Standard guide for extension methodologies).
3. FAO Fisheries Technical Paper No. 424. *Economic Engineering Applied to the Fishery Industry*.
4. CIFT/CMFRI Manuals. *Methods for Socio-economic Surveys in Fisheries*.
5. Subba Rao, N. (1986). *Economics of Fisheries*. Deep & Deep Publications.
6. Adhikari, S. (2018). *Textbook on Fisheries Extension Education*. Narendra Publishing House.
7. Zar, J. H. (2010). *Biostatistical Analysis*. (Essential for data processing in surveys).

## DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY
## CHHATRAPATI SAMBHAJI NAGAR

**B.Sc. III. Year Sem- VI Practical Examination-March/April 20**

**Course code: - Fishery**

**(Based on Theory paper Paper No. 350)**

**SUB/DSC/P/ 376**

**Centre Name:** **Batch. No.**

**Time:-** 4 Hours **Total marks**: 30 (External) + 20 (Internal) = **50 Marks**

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**(Perform any ONE of the following experiments allotted to you by the examiner)**

Q.1. Perform detailed morphometric measurements of the provided fish specimen. Record the Total Length, Standard Length, Head Length, and Body Depth. Calculate two body indices based on your data and comment on its body shape.

**OR** **(10 Marks)**

Determine the meristic counts of the given specimen. Count the dorsal fin rays, anal fin rays, pectoral fin rays, and lateral line scales. Identify the fish up to the species level using the standard taxonomic key provided.

Q.2. Expose the digestive tract/ alimentary canal of the provided fish and comment on its modification based on its feeding habit (Herbivorous *Labeo* I Carnivorous Wallago/ Omnivorous species).

**(10 Marks)**

**OR**

Dissect and expose the gills and accessory respiratory organs of the provided air-breathing fish (*Anabas* I *Clarias / Channa*).

**OR**

Expose the brain and cranial nerves OR the Weberian apparatus of the provided carp specimen.

Q.3. Determine the absolute and relative fecundity of the given mature fish ovary sample using the gravimetric method.

**OR** **(10 Marks)**

Calculate the Condition Factor (K) / Ponderal Index of the given fish population data using Fulton's condition factor formula:

$$K = \frac{nW \times 100}{L^3}$$

(Data for weight w and length L will be provided).

**Internal Marks-**

| | |
|---|---|
| Q.4 -Excursion tour report/Slide/Sample collection/submission. | **05** |
| Q.5- Record Book. | **05** |
| Q.6- punctuality and antecedence. | **05** |
| Q.7. Viva-Voce. | **05** |

**Internal Examiner** **External Examiner**

# DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY
# CHHATRAPATI SAMBHAJI NAGAR

**B.Sc. III. Year Sem- VI Practical Examination-March/April 20**

**Course code: - Fishery**

**(Based on Theory paper Paper No. 351)**

**SUB/DSC/P/ 377**

**Centre Name:** **Batch. No.**

**Time:-** 4 Hours **Total marks**: 30 (External) + 20 (Internal) = **50 Marks**

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**(Perform any ONE of the following experiments allotted to you by the examiner)**

Q. 1. You are provided with the financial dataset for a 1-hectare composite fish culture farm. Categorize the expenses into Fixed Costs and Operational/Variable Costs. Construct a professional Balance Sheet and calculate the Break-Even Point (BEP) and Payback Period for this venture.

**OR** **(10 Marks)**

Analyze the project proposal data provided. Calculate the following profitability indices to evaluate the project's techno-economic feasibility:

Q.2) Based on the raw weekly fish market data provided for High-Value (e.g., Pomfret/Surmai) vs. Low-Value (e.g., Sardine/Tilapia) species:

**OR** **(10 Marks)**

1. Plot a Seasonal Price Fluctuation Graph using the data.
2. Determine the Producer's share in the consumer's rupee and calculate the marketing margins consumed by intermediaries/middlemen.

**OR**

Draft a structured Consumer Preference Questionnaire (minimum 10 points) designed to survey and evaluate consumer buying behavior regarding Fresh Fish vs. Processed/Value-Added Fish Products.

**Q.3)** Design a Participatory Rural Appraisal (PRA) tool framework (such as a resource map or seasonal calendar) to assess the socio-economic status, income, debt distribution, and asset mapping of a local fishing community.

**(10 Marks)**

Prepare an analytical report based on the provided case study regarding Gender Roles in Fisheries.

**OR**

Detail the specific socio-economic contributions and bottlenecks faced by women in post-harvest processing and dry-fish marketing.

**Internal Marks-**

| | |
|---|---|
| Q.4 -Excursion tour report/Slide/Sample collection/submission. | **05** |
| Q.5- Record Book. | **05** |
| Q.6- punctuality and antecedence. | **05** |
| Q.7. Viva-Voce. | **05** |

**Internal Examiner** **External Examiner**