

**Rayat Shikshan Sanstha's**

**YASHAVANTRAO CHAVAN INSTITUTE OF SCIENCE, SATARA**

**(An Autonomous College)**

**Reaccredited by NAAC with 'A+' Grade**

**Choice Based Credit System with Multiple Entry and Multiple Exit Option  
(NEP-2020)**

**Syllabus For**

**Master of Science Part- I**

**Fisheries**

**Semester I and II**

**(Syllabus to be implemented from Academic Year 2023-24)**

**1. TITLE:** Fisheries

**2. YEAR OF IMPLEMENTATION:** 2023 – 2024

**3. PREAMBLE:**

M. Sc. Fisheries course under autonomy has been prepared keeping in view the unique requirements of M. Sc. Fisheries students. The prominence of the contents is to provide students the latest information along with due weightage to the concepts of traditional fisheries so that they are able to understand and appreciate the current interdisciplinary approaches in the study of animal sciences and its role in societal and environmental development. The course content also advanced practical exercises so the students gets a hands on experience of the newest techniques that are currently in use. Project curriculum covering over the two years of the course which is designed in a way that, to give the students first hand research experience as it consists of writing of synopsis, literature review along with actual laboratory work and handling laboratory instruments. The course will also encourage students to hunt higher studies and research in life sciences, for becoming an entrepreneur and enable students to get employed in research institutes.

**4. GENERAL OBJECTIVES OF THE COURSE:**

- To impart the knowledge of animal science is the basic objective of the course.
- To develop scientific attitude among the students and to make the students open minded, enthusiastic, critical and curious so that they enter research field with a positive approach.
- To develop skill in practical work, experiments and handling laboratory instruments.
- To understand scientific terms, concepts, facts, phenomenon and their relationships.
- To make the students aware of natural resource, diversity, environment up to cell biology.
- To enable the students to acquire knowledge of animal cells and different molecules as well as genetics for the wellbeing of human.
- Enrichment of basic knowledge of techniques in fisheries, bioinformatics and genetics.

**5. DURATION:** 02 year

**6. PATTERN:** CBCS Semester

**7. MEDIUM OF INSTRUCTION:** English

## Structure of the

Course:

Level	Sem	Major			RM	OJT	RP	Total
		DSC Mandatory		DSE Elective				
		T	P	T				
6	I	12 (3 Papers)	2	4 (1 paper out of two)	4	---	---	22
	II	12 (3 Papers)	2	4 (1 paper out of two)	---	---	4	22
6.5	III	12 (3 Papers)	2	4 (1 paper out of two)	---	---	6	22
	IV	12 (3 Papers)	---	4 (1 paper out of two)	---	4	---	22
Total		48	6	16	4	4	10	88
		70			8		10	

### M.Sc. Part I Semester I

Nature of the Course	Course Code	Name of the Course
Theory	MZFT 411	BIOSYSTEMATICS AND BIODIVERSITY OF FISHES
	MZFT 412	WATER QUALITY MANAGEMENT
	MZFT 413	LIMNOLOGY

	MZFT 414 (E-I)	AQUACULTURE ENVIRONMENT MANAGEMENT
	MZFT 414 (E-II)	SUSTAINABLE AQUACULTURE
	MZFT 415	RESEARCH METHODOLOGY
<b>Practical</b>	MZFP 416	(BASED ON MZT 411,412,413)

## Semester II

<b>Nature of the Course</b>	<b>Course Code</b>	<b>Name of the Course</b>
<b>Theory</b>	MZFT 421	PRINCIPLES AND PRACTICES OF AQUACULTURE
	MZFT 422	FISH PROCESSING TECHNOLOGY
	MZFT 423	FISHERY TECHNOLOGY
	MZFT 424 (E-I)	AQUACULTURE BIOTECHNOLOGY
	MZFT 424 (E-II)	APPLIED GENETICS IN AQUACULTURE
	MZFT 425	RESEARCH PROJECT
<b>Practical</b>	MZFP 426	(BASED ON MZT 421,422,203)
		OJT/ INT. / RT – RESEARCH TRAINING

**Level 6**  
**Semester I**  
**Course I**  
**MFT 411: Biosystematics and Biodiversity of fishes**

**Course Objectives:**

1. To define taxonomy, and various tasks of taxonomists.
2. To understand the biology of commercially important freshwater, brackish water and marine fin fishes & shellfishes
3. To summarize the Endangered species as per the guidelines of IUCN
4. To know geographical distribution of different fishes

Credits=4	MFT 411 Biosystematics and Biodiversity of fishes	No. of hours per unit/ credits
<b>UNIT-I</b>	<p><b>Definition and basic concepts of biosystematics, taxonomy and classification.</b> ICZN and scientific nomenclature. Taxonomic keys. Modern tools and techniques in Ichthyo-taxonomy. Types and molecular approaches of taxonomy.</p> <p><b>Classification of finfishes and shellfishes</b> (Vertebrate up to Order and Invertebrate up to Sub-class). Method employed in phylogenetic studies. DNA bar-coding and cataloguing. Definition and concept of fish biology study.</p>	(15)
<b>UNIT-II</b>	<p><b>Biology of commercially important freshwater, brackish water and marine fin fishes &amp; shellfishes;</b> Factors influencing aquatic biodiversity; Types of biodiversity - Species diversity in different ecosystems;</p> <p><b>Genetic Diversity and Habitat Diversity;</b> Biodiversity indices and their significance; Concepts of Index of Biotic Integrity (IBI); Global fish diversity and loss of fish biodiversity.</p>	(15)

<b>UNIT-III</b>	<p><b>Endangered species as per the guidelines of IUCN;</b> Threatened aquatic species of India; Issues and strategies of conservation of aquatic species; Factors threatening indigenous species</p> <p><b><i>In-situ and Ex-situ conservation mode.</i></b> Regulations regarding introduction of exotic and invasive aquatic species and their impact on aquatic ecosystem</p>	<b>(15)</b>
<b>Unit- IV</b>	<p><b>Geographical distribution of freshwater, brackish water and marine water fishes in India and abroad.</b></p> <p>Adaptation: Definition, types and mechanism of adaptation in freshwater, brackish water and marine water fishes. General accounts of Agnathan fishes, Chimeras and Dipnoans.</p> <p><b>Migration of fishes.</b> Origin and evolution of major groups of fishes, Evolutionary strategies and morphological innovation. Evolutionary genetics. Living fossils of fishes.</p>	<b>(15)</b>

#### Course Outcomes:

1. they will define taxonomy, and various tasks of taxonomists.
2. Students will understand the biology of commercially important freshwater, brackish water and marine fin fishes & shellfishes
3. They will summarize the Endangered species as per the guidelines of IUCN
4. They will know geographical distribution of different fishes.

#### References:

1. Burukovskii, R.N. 1982. Key to Shrimps and Lobsters. Oxonian Press Pvt. Ltd., Delhi.
2. Day, F. 1989. Fishes – Vol.I. Today and Tomorrow's Printers and Publishers, New Delhi.
3. Day, F. 1994. Fishes – Vol.II. Jagminder Book Agency, New Delhi.
4. Dobson, Andrew P. 1995. Conservation and biodiversity. Scientific American Library, New York.
5. Gunther, A.C.L.G. 1993. An Introduction to The Study of Fishes. Discovery Publishing House, New Delhi.
6. Hochachka, W.P. 1983. The Mollusca (Vol II). Academic Press, London.
7. Jayaram, K.C. 1998 .The Freshwater fishes of the Indian Region. Narendra Publishing House, Delhi.
8. Kapoor, V.C. 2019. Theory And Practice Of Animal Taxonomy And Biodiversity. 8<sup>th</sup> Edition. Oxford & IBH Publishing.
9. Kotpal, R.L. 1992. Mollusca. Rastogi Publications, Meerut.
10. Krishnamurthy, K V. 2006. An advanced textbook on biodiversity : principles and practice. Oxford and IBH Publishing, New Delhi.

**Level 6**  
**Semester I**  
**Course II**

**MFT 412 WATER QUALITY MANAGEMENT**

**Course Objectives:**

1. To describe Water quality and water constituents
2. To explain the dynamics of dissolved oxygen and aeration process.
3. To understand Hatchery management and weed management.
4. To get to know chemical treatment and water pollution.

Credits=4	<b>MZT 412 WATER QUALITY MANAGEMENT</b>	No. of hours per unit/credits
<b>UNIT-I</b>	<ol style="list-style-type: none"> <li>1. <b>Water quality:</b> Constituents of water, Water quality parameters – optimal levels and their management in freshwater fish and brackish water shrimp culture.</li> <li>2. <b>Fertilizers and manures:</b> Different kinds of fertilizers and manures, fertilizer grade, source, rate and frequency of application; Ecological changes taking place after fertilizing; Biofertilizers; Role of inorganic, organic and biofertilizers in aquaculture practices; Utilization of bioactive compounds by microorganisms.</li> <li>3. <b>Liming:</b> Properties of liming materials, lime requirements and application of liming materials to ponds, effects of liming on pond ecosystem.</li> </ol>	<b>(15)</b>
<b>UNIT-II</b>	<ol style="list-style-type: none"> <li>1. <b>Dynamics of dissolved oxygen:</b> Daily changes in dissolved oxygen concentration, oxygen budget of culture ponds; algal die-off, overturns, identification of oxygen problems.</li> <li>2. <b>Aeration:</b> Principles of aeration, emergency aeration, destratification and practical considerations.</li> </ol>	<b>(15)</b>

<b>Unit- III</b>	<p>1. <b>Hatchery management:</b> <u>Fish hatchery</u> - Hatchery protocols, seed rearing technology; Packaging and transport of seed. <u>Shrimp hatchery</u> – Larval rearing; culture and use of different live feed; different chemicals and drugs used; water quality and feed management. Water discharge standards; Effluent treatment in hatcheries.</p> <p>2. <b>Aquatic weed management:</b> Common weeds and problems in culture ponds; chemical, biological and mechanical control methods; Algal bloom control.</p>	<b>(15)</b>
<b>Unit -IV</b>	<p>1. <b>Chemical treatments:</b> Potassium permanganate, hydrogen peroxide, calcium hydroxide; reduction of pH, control of turbidity, salinity, hardness, chlorides, water exchange, chlorine removal; rotenone, formalin and malachite green; methods of applying chemicals.</p> <p>2. Pollution in relation to aquaculture practices.</p>	<b>(15)</b>

**Course Outcome:**

1. Students will be able to Water quality and water constituents.
2. They will explain the dynamics of dissolved oxygen and aeration process.
3. They will understand Hatchery management and weed management.
4. They will know chemical treatment and water pollution.



## References:

1. Adhikari S & Chatterjee DK. 2008. *Management of Tropical Freshwater Ponds*. Daya Publ.
2. Boyd CE and Tucker CS. 1992. *Water Quality and Pond Soil Analyses for Aquaculture*. Alabama Agricultural Experimental Station, Auburn University.
3. Boyd CE. 1979. *Water Quality in Warm Water Fish Ponds*. Auburn University
4. Boyd, CE. 1982. *Water Quality Management for Pond Fish Culture*. Elsevier Sci. Publ. Co.
5. Hephher B & Pruginin Y. 1981. *Commercial Fish Farming*. John-Willey & Sons Inc.
6. Jhingran VG. 1982. *Fish and Fisheries of India*. Hindustan Publishing Corporation, India.
7. Midlen & Redding TA. 1998. *Environmental Management for Aquaculture*. Kluwer.
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9. Rajagopalsamy CBT & Ramadhas V. 2002. *Nutrient Dynamics in Freshwater Fish Culture System*.  
Daya Publ.
10. Sharma LL, Sharma SK, Saini VP & Sharma BK. 2008. *Management of Freshwater Ecosystems*. Agrotech Publ. Academy.
11. Stickney RR. 1979. *Principles of Warm water Aquaculture*. John-Willey & sons Inc.
12. Tucker C.S. 1985. *Channel Catfish Culture*. Elsevier.

**Level 6**  
**Semester I**  
**Course III**  
**MFT 413 LIMNOLOGY**

**Course Objectives:**

1. To explain concept of limnology , inland water types and properties of water.
2. To give various sources of distribution of water and role of various cycles.
3. To demonstrate the structure and function of planktons
4. To criticize importance of productivity and turbidity and process of eutrofication

Credits=4	MFT 413 LIMNOLOGY	No. of hours per unit/ credits
<b>UNIT-I</b>	<ol style="list-style-type: none"> <li>1. <b>Definition and facets</b> of Limnology; Limnology as an applied science.</li> <li>2. <b>Inland water types:</b> Lentic and lotic habitats – their identities and distribution, ponds and lakes, streams and rivers; Major rivers and lakes of India.</li> <li>3. Origin and classification of lakes.</li> <li>4. <b>Anomalous properties of water</b>, their influence on biota in inland waters.</li> <li>5. <b>Temperature and Light:</b> Thermal stratification and its overall impact, thermal classification of lakes; Factors affecting light penetration in natural waters</li> </ol>	<b>(15)</b>
<b>UNIT-II</b>	<ol style="list-style-type: none"> <li>1. <b>Dissolved oxygen:</b> Sources, losses and distribution patterns.</li> <li>2. Identification of oxygen depletion problems and control mechanisms in fish ponds.</li> <li>3. <b>Carbon dioxide:</b> Sources, losses and distribution patterns; role of carbon dioxide in chemical buffering.</li> <li>4. <b>Bio-geochemical cycles:</b> General account of nutrients; Nitrogen and Phosphorus cycles.</li> </ol>	<b>(15)</b>
<b>Unit- III</b>	<ol style="list-style-type: none"> <li>1. <b>Plankton:</b> Composition, classification and distribution patterns in lakes and rivers.</li> <li>2. <b>Benthos:</b> Composition, classification and distribution of benthos in lakes and rivers.</li> <li>3. <b>Nekton</b> and its significance.</li> <li>4. <b>Large Aquatic Plants:</b> Classification, distribution and limnological significance.</li> </ol>	<b>(15)</b>

<b>Unit -IV</b>	<b>UNIT – IV</b> 1. <b>Productivity:</b> Concept of productivity; methods for the estimation of primary, secondary and tertiary productivity; Classification of lakes based on productivity; and productivity in lakes 2. <b>Turbidity:</b> Causes, consequences and control. 3. <b>Eutrophication:</b> Causes, consequences and control mechanisms. 4. <b>Bio-manipulation Concept:</b> Zooplankton as a tool in lake management.	<b>(15)</b>
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**Course Outcomes:**

4. Students will be able to explain concept of limnology, inland water types and properties of water.
5. They will give various sources of distribution of water and role of various cycles.
6. Students will perform how to demonstrate the structure and function of planktons
4. They will criticize importance of productivity and turbidity and process of eutrofication.

**References:**

1. Allan JD.1995. *Stream Ecology: Structure and Function of Running Waters*. Chapman & Hall
2. Cole GA. 1983. *Text book of Limnology*, C.V Mosby Company, St. Louis, Missouri, USA.
3. Goldman CR. and Horne AJ. 1983. *Limnology*. Mc Graw-Hill International Book Company.
4. Golterman, HL. 1975. *Physiological Limnology*. Elsevier Publishing Co., Amsterdam.
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7. Reid GR.1961. *Ecology and Inland waters and Estuaries*. Rein Hold Corp., New York.
8. Ruttner F. 1953. *Fundamentals of Limnology*, Uni. of Toronto press, Toronto.
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1. Edmunds, L.N. 1984 / latest edition- Cell Cycle Clock, Marcel Dekker, New York.
2. Edmunds, L.N. 1987/ latest edition. Cellular & Molecular Basis of Biological Clocks Springer –Verlag Berlin.
3. Gomperts, B.D.(latest edition) Plasma Membrane Academic press, New York.
4. Henning, W (ed) 1987/ latest edition Structure & Function of Eukaryotic Chromosomes Springer –Verlag, Berlin.
5. Moens, P.B. (ed) 1987/ latest edition Meiosis Academic Press, Orlando, Florida, USA.
6. Nomura, M.A./ Tissiers & P. Lengyel (eds). 1974 Latest edition – Ribosomes Cold Spring Harbor Laboratory Press, New York.

**Level 6**  
**SEMESTER I**  
**Elective Course I**

**MFT 414 :E1 Aquaculture Environment Management**

**Course Objectives:** Students will be able to

1. Understand soil and water interaction
2. Analyze soil and water quality standards.
3. Study aquatic pollution.
4. Get knowledge of waste water management

Credits=4	MFT 414:E1 Aquaculture Environment Management	No. of hours per unit/credits
<b>UNIT-I</b>	<b>Soil and water interaction:</b> Physical and chemical properties of soil and water, productivity vs nutrient quality and quantity of soil and water, aquatic microorganisms and their role in carbon, nitrogen, phosphorus and sulphur cycles.	(15)
<b>Unit -II</b>	<b>Soil and water quality standards:</b> organic and inorganic fertilizers, fertilizer grade, source, rate and frequency of application, biofertilizers, use of treated sewage for pond fertilization, ecological changes taking place after fertilization, primary and tertiary production, utilization of bioactive compounds by microorganisms.	(15)
<b>Unit- III</b>	<b>Aquatic pollution:</b> Pollutants - Sewage, pesticides, oils, metals, radioactive wastes, biomedical wastes, etc. Common transport processes of pollutants in the aquatic environment; dispersal of pollutants; Algal blooms and their management, Methods of pollution surveys.	(15)
<b>Unit- IV</b>	<b>Wastewater management:</b> Wastewaters - classification and characteristics of sewage and industrial effluents; Water quality management in culture and hatchery practices, waste discharge standards. Treatment methods for water and waste water; Principles of aeration, chlorination, ozonation and U.V. irradiation.	(15)

**Course Outcomes:** Students should be able to

1. Understand soil and water interaction
2. Analyze soil and water quality standards.
3. Study aquatic pollution.
4. Get knowledge of waste water management

**References :**

1. Adhikari S & Chatterjee DK. 2008. Management of Tropical Freshwater Ponds. Daya Publ.
2. APHA, AWWA, WPCF. 1998. Standard Methods for the Examination of Water and Wastewater, 20th Ed.
3. Boyd, C. E. and Tucker, C. S. 1992. Water Quality and Pond Soil Analysis for Aquaculture, Alabama Agricultural Experimental Station, Auburn University.
4. Boyd CE. 1979. Water Quality in Warm Water Fish Ponds. Auburn University.
5. ICAR. 2006. Handbook of Fisheries and Aquaculture. ICAR.
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12. Gray NF. 2004. Biology of Wastewater Treatment. Oxford University Press.
13. Trivedy RK. 1998. Advances in Wastewater Treatment Technologies. Global Science.

**Level 6**  
**SEMESTER I**  
**Elective Course II**  
**MFT 414 : E2 Sustainable Aquaculture**

**Course Objectives :**Students will be able to

1. Understand trends in global and Indian aquaculture.
2. Study sustainability and development in aquaculture.
3. Know about strategies for sustainability
4. Study guiding principles to sustainable aquaculture development.

Credits=4	MFT 414: E2 Sustainable Aquaculture	No. ofhours perunit/ Credits
<b>UNIT-I</b>	<b>Present scenario and problems:</b> Trends in global and Indian aquaculture; different farming systems; intensive systems and constraints - environmental degradation and disease outbreaks.	(15)
<b>Unit -II</b>	<b>A Sustainability and development:</b> Systems approach and its application in aquaculture with special reference to resource- poor systems; Role of aquatic resources in food and nutrition; Aquatic resource and livelihood systems.  <b>B Socio-economic issues:</b> Conflicts over water and land use; conflicts of interest between aqua farmers and fishermen; resistance from local public; anti-dumping duties	(15)
<b>Unit- III</b>	<b>Strategies for sustainability:</b> Sustainability concept; food security; biosecurity; organic farming; integrated farming; responsible aquaculture; rotational aquaculture; bioremediation; role of biotechnology, traceability. Application of renewable energy in aquaculture - solar energy, wind, and tidal energy, Seed certification, Sustainable use of antibiotics.	(15)

<b>Unit -IV</b>	<b>Economic viability:</b> export vs. domestic marketing, value addition. <b>Guiding principles to sustainable aquaculture development:</b> Coastal Aquaculture Guidelines Source Book, FAO Code of Conduct for Responsible Fisheries; Holmenskollen Guidelines for Sustainable Aquaculture.	<b>(15)</b>
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**Course Outcomes:** Students should be able to

1. Understand trends in global and Indian aquaculture.
2. Study sustainability and development in aquaculture.
3. Know about strategies for sustainability
4. Study guiding principles to sustainable aquaculture development

References:

- 1) Bardach JE. 1997. Sustainable Aquaculture. John Wiley & Sons.
- 2) Bardach JE, Rhyther JH & Mc. Larney WO. 1972. Aquaculture Farming and Husbandry of Freshwater and Marine Organisms. John Wiley & Sons.
- 3) Beets WC. 1990. Raising and Sustaining Productivity of Small-Holder Farming Systems in the Tropics. AgbePubl.
- 4) Edwards P, Little DC & Demaine H. (Eds.). 2002. Rural Aquaculture. CABI.
- 5) FAO 2001. Planning and Management for Sustainable Coastal Aquaculture Development. FAO.
- 6) Imai T. 1978. Aquaculture in Shallow Seas. Progress in Shallow Sea Culture. Amerind Publ.
- 7) James PM. 1983. Handbook of Mariculture. Vol. I. Crustacean Aquaculture. CRC Press.
- 8) Leung P, Lee CS & O'Brien JP. (Eds.). 2007. Species and System Selection for Sustainable Aquaculture. Blackwell Publ.
- 9) Midlen & Redding TA. 1998. Environmental Management for Aquaculture. Chapman & Hall.
- 10) Selvamani BR & Mahadevan RK. 2008. Aquaculture, Trends and Issues. Campus Books International.



**Level 6**  
**SEMESTER I**  
**Lab I**

**MFP 415 (Practical based on course – MFT 411, MFT 412 & MFT 413)**

**Course objective:** Student should be able to:

1. Classify specimens from different classes or phylum.
2. Analyze different physicochemical parameter of water.
3. Categorize different types of glycosaminoglycans from tissue.
4. Demonstrate various types of nucleus from WBCs and liver

Credits=4	MZFP 415 (MFT 411, MFT 412 & MFT 413)	No. of hours per unit/ credits
<b>II</b>	<p>➤ <b>Practical Based on MFT 411</b></p> <ol style="list-style-type: none"> <li>1. Identification of common finfishes available from different aquatic resources of India.</li> <li>2. Identification of common shellfishes available from different aquatic resources of India.</li> <li>3. Identification of Agnathan fishes, Chimera, Dipnoan and Coelacanth fishes.</li> <li>4. Study of distribution and adaptive modifications of different groups of fishes.</li> <li>5. Study of migratory behavior of fishes</li> <li>6. Study the morphometry of different fishes.</li> <li>7. Preparation of taxonomic key.</li> </ol>	<b>60</b>
	<p>➤ <b>Practical Based on (MFT 412)</b></p> <ol style="list-style-type: none"> <li>1. Determination of temperature, pH, water sample.</li> <li>2. Estimation of total alkalinity of pond water sample</li> <li>3. Estimation of dissolved oxygen of pond water sample</li> <li>4. Estimation of free carbon dioxide of pond water sample</li> <li>5. 6. Estimation of phosphates and nitrites of pond water sample</li> <li>6. Estimation of total hardness.</li> </ol>	

	<p>7. Estimation of turbidity of pond water sample  8. Estimation of primary productivity of pond water sample.</p> <p><b>Practical Based on (MFT 413)</b></p> <p>1 Collection of zooplanktons  2 Identification of zoo planktons  3 Preservation of phytoplankton samples  4 Collection of phytoplanktons  5 Identification of phytoplanktons  6 Mounting of zoo and phytoplanktons  7 Qualitative and quantitative study of zooplanktons</p>	
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**Course outcomes:** Student will be able to:

1. Identify different types of fishes in different water bodies.
2. Analyze different physicochemical parameter of water.
3. Categorize different types of Planktons .
4. Demonstrate various types of qualitative and quantitavie study of zooplanktons.

**Level 6**  
**SEMESTER I**  
**Course I**  
**MFT - 415 Research Methodology**

**Course objectives:** Student should be able to:

- 1 To understand the different types of research work.
2. To present the research work scientifically.
3. Understand the concept of Literature review.
4. To develop technical skills in Research students.

Credits=4	<b>Research Methodology</b>	<b>No. of hours per unit/ credits</b>
<b>I</b>	<p><b>1. Concept of Scientific Research:</b>            1.1 Meaning of Research;            1.2 Objectives of research,            1.3 Motivation in research;            1.4 Types of research (Descriptive, Analytical, Applied, Fundamental, Quantitative, Qualitative, Conceptual, Empirical and other types)            1.5 Research methods,            1.6 Experimental design,            1.7 Research process : Steps of research process(formulation of problem, literature survey, Developing working problem, designing methodology of data collection, Analysis of Data and its presentation)            1.8 Concept of good research.</p>	<b>15</b>
<b>II</b>	<p><b>1. Literature Survey and Problem Definition:</b>            1.1 Need of Reviewing Literature,            1.2 What to review and for what purpose,            1.2 Literature Search Procedure,            1.3 Sources of Literature,(SciHub, Pbmед, Google Scholer)            1.4 Documentation and management of bibliography with softwares (e.g. EndNote, Mendeley etc.).            1.5 Problem definition  <b>2. Planning of Research:</b>            2.1 Formulation of the Selected Problems,            2.2 Hypothesis formation,            2.3 Reasons for undertaking the problem            2.4 Research Design/Plan.</p>	<b>15</b>
<b>III</b>	<p><b>1. Research communication&amp; presentation:</b>            1.1 Scientific language and scientific writing            1.2 Structures of Research proposals,            1.3 How to write Synopsis,            1.4 How to write review article,            1.5 How to write research paper (manuscript) (Abstract, Introduction, Review literature, methodology, Results, Discussions, Summary and Conclusion, Bibliography etc),            1.6 How to write research project</p>	<b>15</b>

	1.8 Presentations of research: Graphical, Tabular, Animation, Power point 2. Originality & Integrity, 3. Intellectual Property Rights, 4. Patents 5. Plagiarism in research (Software used in plagiarism checking ) 6. Terms related research (ISSN, ISBN, DOI, impact factor, citation index, H index, I index)	
<b>IV</b>	<b>1. Ethical issues and bio-safety regulation:</b> 1.1 DBT Guidelines for Bio-safety, <b>2. Ethics in use of Experimental animals:</b> 2.1 Institutional Animal ethics committee, 2.2 CPCSEA guidelines for animal experimentation, 2.3 ICMR guidelines for experiments involving humans. <b>3. Biodiversity laws:</b> 3.1 Guidelines and regulations of Bioresources utilization for commercial and research purpose. 3.2 The Biological Diversity Act, 3.3 Wildlife (Protection) Act, 3.4 Forest (Conservation) Conservation Act. 4. Animal Handling 5. Layout of animal house	<b>15</b>

**Course outcomes:** Student will be able to

1. Design a research framework.
2. Develop soft skills in compilation and presentation of their research work.
3. Prepare a draft research/ review article based on a Literature Review.

**References:**

1. Kothari. C. R. 2004. Research Methodology: Methods and Techniques, New Age International (P) Limited, Publishers, New Delhi – 110002.
2. Jennifer Peat. 2002. Scientific Writing Easy when you know how. BMJ Books.
3. Brendan Hennessy. 2006. Writing Feature Articles, Fourth edition, Focal Elsevier.
4. Margaret Cargill and Patrick O'Connor. 2009. Writing Scientific Research Articles: Strategy and Steps. Willey-Blackwell, A John Wiley & Sons, Ltd., UK.
5. Rastogi, 2008, Fundamentals of Biostatistics, ANE Books
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8. Barnes & Gray, 2003, *Bioinformatics for Geneticists*. Wiley
9. Campbel, 2006, *Discovering Genomics, Proteomics and Bioinformatics*. LPE
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**Level 6**  
**M.Sc.-I Semester-II**

**MFT – 421- PRINCIPLES AND PRACTICES OF AQUACULTURE**

**Course Objectives:** Students will able to

1. Understand about basic aquaculture and its history
2. To introduce bundh breeding and Induced breeding of carp by hypophysation and use of synthetic hormones
3. Students know the culturing of various fishes shrimps and crabs.
4. Understand the culture of fed fish a sea weeds: Major seaweed species of commercial importance; methods of culture

Credits=4	SEMESTER-II MFT 421– PRINCIPLES AND PRACTICES OF AQUACULTURE	No. ofhours perunit/ credits
<b>UNIT-I</b>	<b>UNIT - I</b> 1. <b>Basics of Aquaculture:</b> Definition, significance and classification; History of aquaculture; Cultivable species – freshwater, brackish water and marine; A knowledge of inland water bodies suitable for culture in India. 2. Criteria for the selection of a species for culture. 3. <b>Culture practices of fish and shrimp:</b> Traditional, extensive, modified extensive, semi-intensive and intensive cultures. 4. Concept of monoculture, polyculture and integrated fish farming	<b>(15)</b>

<b>UNIT-II</b>	<b>UNIT-II</b> 1. <b>Bundh breeding and Induced breeding</b> of carp by hypophysation and use of synthetic hormones. 2. <b>Culture of Indian major carps</b> – nursery, rearing and production ponds. 3. Culture of air-breathing fishes in India. 4. Culture of giant fresh water prawn, <i>Macrobrachium rosenbergii</i>	<b>(15)</b>
<b>UNIT-III</b>	<b>UNIT-III</b> 1. <b>Culture of milk fish</b> , <i>Chanos chanos</i> . 2. Culture of Asian sea bass, <i>Lates calcarifer</i> . 3. <b>Culture of shrimp</b> , <i>Penaeus monodon</i> . 4. Culture of crab, <i>Scylla serrata</i> .	<b>(15)</b>
<b>UNIT-IV</b>	<b>UNIT-IV</b> 1. <b>Sewage-fed fish culture</b> . 2. Culture of ornamental fishes. 3. Culture of pearl oysters. 4. <b>Culture of sea weeds</b> : Major seaweed species of commercial importance; methods of culture.	<b>(15)</b>

**Course Outcomes:** Students should be able to

- 1 students will able to Understand about basic aquaculture and its history
- 2 They will know how to introduce bundh breeding and Induced breeding of carp by hypophysation and use of synthetic hormones
- 3 Students will know the culturing of various fishes shrimps and crabs.
- 4 they will Understand the culture of fed fish a sea weeds: Major seaweed species of commercial importance; methods of culture

**References:**

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14. Stickney RR. 1979. *Principles of Warmwater Fish Culture*, John Wiley & Sons.

**Level 6**  
**SEMESTER II**  
**Course II**  
**MFT 422 - FISH PROCESSING TECHNOLOGY**

**Course Objectives:** Students will able to

1. Understand about the minor and major components about fishes.
2. Understand about Biochemical and microbial spoilage of fish; factors affecting spoilage of fish.
3. Understand handling and preservation of fish.
4. Understand about quality management and certification of fishery products.

Credits=4	SEMESTER-II MFT 422 FISH PROCESSING TECHNOLOGY	No. ofhours perunit/c redits
<b>UNIT-I</b>	<b>Process Biochemistry</b> 1. Major and minor constituents of fish, their distribution and function - moisture, proteins, lipids, carbohydrates, vitamins and minerals. 2. Post-mortem biochemical changes in fish- rigor mortis, autolysis, auto-oxidation and their significance. 3. Toxins and toxic substances in fish.	<b>(15)</b>



<b>UNIT-II</b>	<p><b>Microbiology</b></p> <ol style="list-style-type: none"> <li>1. Biochemical and microbial spoilage of fish; factors affecting spoilage of fish.</li> <li>2. Role of bacteria and moulds in fish preservation - pathogenic organisms encountered in fish products, faecal indicator organisms.</li> </ol>	<b>(15)</b>
<b>UNIT-III</b>	<p><b>Handling and Fish Preservation</b></p> <ol style="list-style-type: none"> <li>1. Handling, storage and transport of fresh fish, sanitary and phyto-sanitary requirements for maintenance of quality.</li> <li>2. Principles of fish preservation; preservation of fish by curing, drying, salting and smoking; chilling and freezing of fish; canning of fish and fish products.</li> <li>3. Modern techniques employed in fish preservation: Accelerated Freeze Drying (AFD), Irradiation.</li> <li>4. Fishery by-products and waste utilization.</li> </ol>	<b>(15)</b>
<b>UNIT-IV</b>	<p><b>Quality Management and Certification</b></p> <ol style="list-style-type: none"> <li>1. HACCP (Hazard Analysis and Critical Control Points) and Good Manufacturing Practices: HACCP Principles, Practical aspects of planning and implementation, Verification, Validation and Audit.</li> <li>2. National and International Standards - ISO 9000 Series, 2000 Series of Quality Assurance System, Codex Alimentarius Commission, Food Safety and Standards Act of India 2006.</li> </ol>	<b>(15)</b>

**Course Outcomes:** Students should be able to

1. Students will able to Understand about the minor and major components about fishes.
2. They will know about Biochemical and microbial spoilage of fish; factors affecting spoilage of fish.
3. students will able to handle and preservation of fish.
4. They will gain knowledge about quality management and certification of fishery products.

**References:**

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13. Rudolf K. 1969. *Freezing and Irradiation of Fish*. Fishing News (Books).
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**Level 6**  
**SEMESTER II**  
**Course III**  
**MFT 423 – FISHERY TECHNOLOGY**

**Course Objectives :**Students will able to

- 1,Study Reproductive technology in aquaculture
- 2Study application of technological tools in fish breeding.
- 3Understand nutrition, health, processing and other issues in fisheries.
- 4 Study cryopreservation of gametes, embryos and stemcells.IPR issuesin Biotechnnology.

Credits=4	SEMESTER-II MFT 423 – Fishery Technology	No. ofhours perunit/ credits
<b>UNIT-I</b>	<b>Fishing craft and gear technology:</b> Conventional fishing methods: types of crafts and gears, Unconventional fishing methods, Modern methods of fishing, Rules and regulations for fishing operations and safety at sea.	(15)
<b>UNIT-II</b>	<b>Packing of fish and fishery products:</b> Food packing, its purpose and procedures, technological aspects of packing fishery products, packing of fresh and frozen fish, packaging for transport, shipping and institutional	(15)

	supplies, packing standards for domestic and international trade	
<b>UNIT-III</b>	<b>Biotechnology in Aquaculture:</b> Prospects of aquaculture biotechnology, Biotechnological tools in diagnosis of diseases in aquaculture, Application of hybridism technology in aquaculture, Cryopreservation technology in fishes, Application of biotechnology in health management in aquaculture	<b>(15)</b>
<b>UNIT-IV</b>	<b>Post Harvest Technology:</b> Reasons for spoilage of fishes, methods for fish preservation, refrigeration, deep freezing, freeze drying, salting, smoking, drying, canning, demerits of fish preservation, fish by products, HACCP for fish processing industry.	<b>(15)</b>

**Course Outcomes:** Students should be able to

1. Study Reproductive biotechnology in aquaculture.
2. Study application of biotechnological tools in fish breeding.
3. Understand nutrition, health, processing and other issues in fisheries.
4. Study cryopreservation of gametes, embryos and stem cells. IPR issues in Biotechnology.

#### References

1. Bhattacharya S. 1992. *Hormones in Pisciculture*. Biology Education, Vol. 9 No.1 pp.31- 41.
2. CIFE. 1998. Summer School Manuals, Mumbai.
  - i). *Recent Developments in Biotechnology: Applications to Aquaculture & Fisheries*.
  - ii). *Genetics and Biotechnological Tools in Aquaculture and Fisheries*.
3. Felix S. 2007. *Molecular Diagnostic Biotechnology in Aquaculture*. Daya Publ. House.
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9. Ramesh RC. 2007. *Microbial Biotechnology in Agriculture and Aquaculture*. Vol. II. Science Publ.
10. Reddy PVGK, Ayyappan S, Thampy DM & Gopalakrishna 2005. *Text Book of Fish Genetics and Biotechnol.* ICAR
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**Level 6**  
**SEMESTER II**  
**Elective Course I**

**MFT 424 : AQUACULTURE BIOTECHNOLOGY**

**Course Outcomes:** Students should be able to

1. Study different methods of genetic engineering
2. Get knowledge of Fish breeding
3. Understand prospects of aquaculture biotechnology
4. Know about post harvest fishery technology

Credits=4	SEMESTER-II MFT 423 : E1 AQUACULTURE BIOTECHNOLOGY	No. of hours per unit/ credits
<b>UNIT-I</b>	<p><b>Biotechnology:</b> Origin, definition and knowledge of different branches.</p> <p>2. <b>Genetic Engineering:</b> Recombinant DNA technology; Tools of genetic engineering – cloning vectors, restriction endonucleases, DNA ligases, topoisomerases, methylases, nucleases, polymerases, reverse transcriptase and their functions.</p> <p>3. Screening and analysis of recombinants: Colony hybridization technique, immunological tests.</p> <p>4. <b>Transgenics:</b> Principles of Transgenic technology and its applications in fisheries.</p>	<b>(15)</b>
<b>UNIT-II</b>	<p><b>Fish breeding:</b></p> <p>1. Synthetic hormones for induced breeding – GnRH analogue structure and function; Selective breeding for improving fish stocks - hybridization in Indian fishes.</p> <p>2. Androgenesis, Gynogenesis, Polyploidy and Sex reversal.</p> <p>3. Hormonal regulation of reproduction and molting in important cultivable crustaceans.</p> <p>4. <b>Gene bank and Conservation:</b> Cryopreservation of gametes and embryos. Embryo transfer technology.</p>	<b>(15)</b>

<b>UNIT-III</b>	<ol style="list-style-type: none"> <li>1. <b>Feed technology:</b> Micro encapsulated feeds; micro coated feeds; micro particulate feeds and bio-encapsulated feeds; mycotoxins and their effects on feeds.</li> <li>2. <b>Algal biotechnology:</b> Biotechnological approaches for production of important microalgae; single cell protein from <i>Spirulina</i>; vitamins, minerals and omega3 fatty acids from micro algae; enrichment of micro algae with micronutrients.</li> <li>3. Application of Nanotechnology in aquaculture; A general knowledge of tissue culture.</li> </ol>	<b>(15)</b>
<b>UNIT-IV</b>	<ol style="list-style-type: none"> <li>1. <b>Health management:</b> DNA and RNA vaccines; molecular diagnosis of viral diseases; Biofilms and its impact on health management; genetically modified microorganisms as probiotics, immunostimulants, bioremediation of soil and water.</li> <li>2. Nitrogen fixation in aquatic environment and Biofertilizers.</li> <li>3. <b>Post-harvest biotechnology:</b> Delaying of spoilage; biosensors.</li> </ol>	<b>(15)</b>

**Course Outcomes:** Students should be able to

1. Study method of genetic engineering.
2. Study application of fish breeding.
3. Understand feed technology and algal biotechnology.
4. Study health management and diagnosis of diseases

**References:**

1. Bhattacharya S. 1992. *Hormones in Pisciculture*. Biology Education, Vol. 9 No.1 pp.31- 41.
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  - i). *Recent Developments in Biotechnology: Applications to Aquaculture & Fisheries*.
  - ii). *Genetics and Biotechnological Tools in Aquaculture and Fisheries*.
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**Level 6**  
**SEMESTER II**  
**Elective Course II**  
**MFT 424 : APPLIED GENETICS IN AQUACULTURE**

**Course Objective :**Students will be able to

1. Study origin and advancement in genetics
2. Study application and methods of selection of molecular markers.
3. Understand Inbreeding and conservative genetics
4. Impart knowledge of fish breeding and genetic management strategies.

Credits=4	SEMESTER-II MZFT 424 : E2Applied Genetics In Aquaculture	No. of hours per unit/ credits
<b>UNIT-I</b>	<p><b>Introduction:</b> Origin and advancement in genetics; physical basis of heredity; genetic correlation, domestication and local adaptation. Chromosome manipulation: Ploidy induction methods - triploidy and tetraploidy, advantages and disadvantages of polyploids, androgenesis and gynogenesis.</p> <p><b>Sex determination:</b> Sex differentiation and sex reversal in fishes, sex control and its role in aquaculture.</p>	<b>(15)</b>
<b>UNIT-II</b>	<p><b>Selection:</b> Scope, application and methods of selection, marker assisted selection-biochemical and molecular markers. Molecular tools for stock differentiation for selection. T V Hybridization: Heterosis, hybrid vigour, introgression.</p>	<b>(15)</b>
<b>UNIT-III</b>	<p><b>Inbreeding:</b> Methods of estimation, inbreeding depression and consequences, measures to reduce inbreeding in hatcheries.</p> <p>Conservation genetics: Genetic resources of India and conservation, endangered species, cryopreservation of fish gametes.</p>	<b>(15)</b>

<b>UNIT-IV</b>	<b>Cytogenetics:</b> Importance and karyotyping. Fish breeding: History and advancement of fish breeding, mode of reproduction, basic breeding methods and breeding programmes and goals. Genetic management strategies: Environmental impacts, Lessons from the green revolution, Bioprospecting, GMOs and their detection.	<b>(15)</b>
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**Course Outcomes:** Students should be able to

1. Study origin and advancement in genetics
2. Study application and methods of selection of molecular markers.
3. Understand Inbreeding and conservative genetics
4. Impart knowledge of fish breeding and genetic management strategies.

**References :**

1. Carvalho GR & Pitcher TJ. (Eds.). 1995. Molecular Genetics in Fisheries. Chapman & Hall. Falconer DS & Mackay. 1996.
2. Introduction to Quantitative Genetics. 4th Ed. Longman. Kanakaraj P. 2001.
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5. Applied Fish Genetics. Fishing Chimes. Pandian TJ, Strüssmann CA & Marian MP. 2005.
6. Fish Genetics and Aquaculture Biotechnology. Science Publ. Purdom CE. 1993.
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11. Genetics for Fish Hatchery Managers. 2nd Ed. AVI Publ. Thorpe JE, Gall GAE, Lannan JE & Nash CE. (Eds.). 1995.
12. Conservation of Fish and Shellfish Resources, Managing Diversity.



**Level 6**  
**SEMESTER II**  
**Practical I**  
**MFP-426: (MFT 421,MFT 422& MFT 423)**

**Course Objectives:** Student should be able

1. Describe endocrine gland and their role in Physiology.
2. Differentiate types of blood cells
3. Estimate total amount of protein, lipid, glycogen, cholesterol and vitamin C from sample.
4. Apply the knowledge of biostatics in arithmetic calculations.

Credits=4	MZP 205: (MZT 421, MZT 422 & MZT 423)	No. of hours per unit/credits
<b>II</b>	<p>➤ <b>Practical Based on MZT 421</b></p> <ol style="list-style-type: none"> <li>1. Identification of important cultivable species of fin fish</li> <li>2. Identification of important cultivable species of shell fish</li> <li>3. Common unwanted (weed and predatory) fishes in culture ponds – identification and their impact in aquaculture.</li> <li>4. Dissection of pituitary gland and preparation of pituitary extract. Method of dosage</li> </ol> <ol style="list-style-type: none"> <li>5. Identification of aquatic insects and molluscs in ponds.</li> <li>6. Common floating, emergent and submerged aquatic vegetation in ponds.</li> <li>7. Field visit to culture pond</li> <li>.</li> </ol> <p><b>Practical Based on MZT 422</b></p> <ol style="list-style-type: none"> <li>1. Evaluation of fish/ fishery products for organoleptic study</li> <li>2. Study of Spoilage microorganisms</li> <li>3. Isolation of pathogenic bacteria associated with fish and fishery products.</li> <li>4. Traditional methods of fish preservation Salting, drying.</li> <li>5. Fish preservation method Smoking and freezing.</li> <li>6. Determination of acidity in fish pickles</li> <li>7. Determination of salt content in fish .</li> <li>8. Determination of moisture content in fish</li> </ol> <p>➤ <b>Practical Based on MZT 423</b></p> <ol style="list-style-type: none"> <li>1. Identification of fishing crafts and gears</li> <li>2. Identification of fishing accessories- floats, sinkers, hook, synthetic and natural fibers, twines, ropes, iron wares</li> <li>3. Identification of different types of gear materials.</li> </ol>	<b>60</b>

	<p>4. Processing on fish and fish products.</p> <p>5. Field visit to fish processing unit.</p>	
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