VIDYASAGAR UNIVERSITY

Midnapore, West Bengal

PROPOSED CURRICULUM&SYLLABUS (DRAFT) OF

B. Sc. (HONOURS/ HONOURS WITH RESEARCH)

MAJOR IN AQUACULTURE MANAGEMENT

4-YEAR UNDERGRADUATE PROGRAMME

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

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Based on

Curriculum & Credit Framework for Undergraduate Programmes (CCFUP), 2023& NEP, 2020

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VIDYASAGAR UNIVERSITY
B. Sc. (HONOURS/ HONOURS WITH RESEARCH) MAJOR IN AQUACULTURE MANAGEMENT
(under CCFUP, 2023)

Level	YR.	SEM	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
								CA	ESE	TOTAL
B.Sc. (Hons./ Hons. with Research)	4th	VII	SEMESTER-VII							
			Major-14	ACMHMJ14	T: Reproduction in Finfish & Shellfish; P: Practical	4	3-0-1	15	60	75
			Major-15	ACMHMJ15	T: Advanced Aquatic Animal Nutrition; P: Practical	4	3-0-1	15	60	75
			CRM	ACMHCRM	T: Research Methodology and Ethics;	4	3-1-0	15	60	75
			Major Elective-03	ACMHDSE03	Ornamental Fish and Aquarium Management OR Statistics and Bioinformatics OR Remote Sensing & GIS	4	3-0-1/ 3-1-0	15	60	75
			Minor-07 (Disc.-I)	ACMMIN07	T: Ornamental Fish and Aquarium Management; P: Practical *(To be taken by the other Discipline)*	4	3-0-1	15	60	75
			Semester-VII Total			20				375
		VIII	SEMESTER-VIII							
			Major-16	ACMHMJ16	T: Genetics, Breeding and Hatchery Management; P: Practical	4	3-0-1	15	60	75
			Major Elective-04	ACMHDSE04	Aquatic Microbiology OR Fisheries Engineering	4	3-0-1	15	60	75
			Major Elective-05	ACMHDSE05	T: ICT and AI Application in Fisheries; P: Practical	4	3-0-1	15	60	75
			Major Elective-06	ACMHDSE06	T: Modern Aquaculture Technologies; P: Practical	4	3-0-1	15	60	75
			Research	ACMHRD	DISSERTATION:	*8*	*0-0-8*	*-*	*150*	*150*
			Minor-8 (Disc.-II)	ACMMIN08	T: Genetics, Breeding and Hatchery Management; P: Practical *(To be taken by the other Discipline)*	4	3-0-1	15	60	75
			Semester-VIII Total			20				375
			YEAR-4			40				750
		To be awarded *B. Sc. (Honours / Honours with Research) Major in* Aquaculture Management				166	Marks (Year: I+II+III+IV)			3075

FOR HONOURS STUDENTS

FOR HONOURS WITH RESEARCH STUDENTS

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

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SEMESTER-VII

MAJOR (MJ)

MJ-14: Reproduction in Finfish & Shellfish **Credits 04 (Full Marks:75)**

Course outcome:

In recent years, major problems facing aquaculture today is the lack of knowledge of complete life cycles and mass production of seedling of targeted species. So, there is need of domestication of diversified aquaculture species. As there is a depletion of natural fish resources for various reasons, there is a need for evolving species specific technologies to culture commercially important finfish and shellfish species. The basic requirement of successful culture of any species of fish is the availability of healthy seedling in desired quantity. As the availability of seed primarily depends on the efficient functioning of the reproductive organs, it is utmost necessary for the students to understand the basic concepts of reproduction in fish and reproductive technology.

MJ-14T: Reproduction in Finfish & Shellfish (Theory) *Credits 03 (45 hrs.)*

Course Content:

Sexuality in fishes, Sexual dimorphism. Courtship and mating. Reproductive strategies, Reproductive cycle, fecundity and spawning. Development of gonads, Gametogenesis. Gonad anatomy and reproductive mechanisms in important finfish and shellfish species. Environmental influence and control. Endocrine and neuroendocrine regulation of reproduction in finfish and shellfish. Role of pheromones in reproduction. Factors affecting maturation and spawning. Artificial propagation technique. Brood husbandry: brood raising, captive rearing and maturation, brood health care and stress management, brood transport. Nutritional and environmental requirement for broodstocks and for early maturation.

MJ-14P: Reproduction in Finfish & Shellfish (Practical) *Credits 01 (30 hrs)*

Course Outline:

- Demonstration of reproductive system (male and female) of fish.
- Dissection and display of pituitary gland.
- Study of reproductive phase, gonado-somatic index and condition factor of fish.
- Studies on oocyte development and stages of oocytes.
- Study of fecundity, ova diameter of different fishes.
- Study of morpho-histology of gonads, pituitary gland and other related tissues

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- Broodstock management practices by handling, transport, and stress care
- Seminar talk
- Field visit

Suggested Readings:

1. Fish Neuroendocrinology by Reinecke, Zaccone & Kapoor. CRC Press. 2006.
2. Fish Physiology (V.IXB) by Hoar, Randall & Donaldson. Academic Press, New York, 1983.
3. Fish Reproduction by Arukwe, Kapoor and Rocha, CRC Press, NW. 2008.
4. Fish Reproduction by N.K. Agarwal. APH publication New Delhi. 2008.
5. Fish Reproductive Biology by Jacobsen. John Wiley. 2016.

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MJ-15: Advanced Aquatic Animal Nutrition **Credits 04 (Full Marks:75)**

MJ-15T: Advanced Aquatic Animal Nutrition (Theory *Credits 03 (45 hrs.)*

Course outcomes:

Describe the importance of different dietary components, effective feed formulation, balanced diets, use of ingredients for aquafeeds and the production of aquafeeds. Apply the knowledge of nutritional concepts to optimize growth efficiency and product quality for the major groups of farmed aquatic animals: fish, crustaceans and molluscs. Design aquaculture nutrition experiments and analyse and evaluate data. Discuss the importance of nutrition research for sustainable aquaculture and the responsible use of global resources

Course Content:

Basic concepts of fish nutrition, study the Bioenergetics in fish. Different biomolecules in fish nutrition and their importance. Fish feed ingredients. Scenario of feed ingredients and feed industry in world and India. Importance of additives formulation of nutritionally balanced diet (amino acid, micronutrients). Process of feed formulation, Packaging and labeling, Factors affecting feed manufacture and stability of nutrients, Effects of processing on the nutritional value of feeds, Processing methods for non-compacting feed; Storage of feed and quality deterioration, CGMPs and HACCP feed regulation, farm made feed. Feed for early larval development. Nutraceuticals in fish feed and their importance. Principles of nutrigenomics: Methodologies, Genomics, Transcriptomics, Proteomics, Metabolomics and Nutrigenomics, Gene structure and Regulation, Nutritionally Important genes, Environmental aspects of fish nutrition study. Eco-friendly feed, Improving nutrient utilization through exogenous phytase and acidifiers, Methods of enhancing feed digestibility, Biofloc and probiotics influences on nutrient utilization. Judicious use of feed.

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MJ-15P: Advanced Aquatic Animal Nutrition (Practical) *Credits 01 (30 hrs.)*

Course Outline:

- Proximate analysis of fish feed ingredients and prepared feed.
- Fish feed preparation using different ingredients.
- Water stability study of fish feed.
- Study the growth, FCR, PER, NPU and digestibility of feed
- Study the requirements of fish feed in different aquaculture system.
- Feed application process and feeding devices.
- Visit to feed manufacturing industry / Feed Company/ Fish farm to study the feeding process.

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Suggested Readings:

1. Lehninger, A.L. 1990. Biochemistry, CBS publishers Pvt. Ltd., Shahdara, Delhi.
2. Lovell Tom. 2nd Edition. Nutrition and Feeding of Fish. Springer, India, Private Ltd.
3. Meera Vashis hit. 1998. Food nutrition and processing –Anmol publication pvt. Ltd.
4. Ronald W. Hardy, Sadasivam J. Kaushik. 2021. 4th edt. Fish Nutrition. Academic Press.
5. S.S. de Silva. T.A. Anderson. 1994. Fish Nutrition in Aquaculture. Springer Science.
6. Swaminathan, M. 1985. Hand book of Food and Nutrition-The Bangalore Printing and Publishing Company, Ltd. Mysore.
7. Wilson, K. and Walker, J. 2000. Practical Biochemistry: Principles and Techniques. University of Cambridge, UK

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COMPULSORY RESEARCH METHODOLOGY (CRM)

[for both Hons. and Hons. with Research students]

CRM: Research Methodology and Ethics

Course outcomes:

Discuss research methodology and the technique of defining a research problem. Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review. Explain various research designs and their characteristics. Explain the art of interpretation and the art of writing research reports. Develop the research mind of the student and they learn about different ethics related to research.

CRM (T): Research Methodology and Ethics (Theory) ***Credits 04 (60 hrs.)***

Course Content:

Definition of Research Methodology, Logical framework, Different kinds of Research Style of Referencing and Bibliography, Reviewing Articles and Books, and writing a good Research Proposal. Ethics with respect to science and research, scientific misconduct: Falsification, Fabrication, and Plagiarism (FFP), duplicate and overlapping publications. Publication ethics: definition, introduction, and importance. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types, Violation of publication ethics, authorship and contributorship, Identification of publication misconduct, complaints and appeals, Predatory publishers and journals. 1. Indexing databases Citation databases: Web of Science, Scopus, etc. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score, Metrics: h-index, g index.

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Suggested Readings:

1. Essentials of Biostatistics & Research Methodology, by Indranil Shah (Author), Boddy Paul (Author), third edition, Academic Publishers (2020).
2. Biostatistics and Research Methodology, by G. Nageswara Rao (Author), Pharma Med Press / BSP Books; 1st edition (2018).
3. Comprehensive textbook of biostatistics and research methodology, by Dr. S. Kartikeyan, Dr. R. M. Chaturvedi, Mr. R. M. Bhosale, 1 first edition, 2016, Bhalani Publishing House, Parel, Mumbai 400 012, Maharashtra, India.
4. Biostatistics & Research Methodology, by Dr. Richa Agarwal, Dr. Sukhbir Singh,
5. Dr. Neelam Sharma & amp; Dr. Tania Bose, first edition 2021 R. Narain Publishers & Distributors.
6. Research Methods and Statistics: An Integrated Approach, By: Janie H. Wilson and Joye, first edition 2017, AGE Publications, Inc.

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Major Elective – 03:

(Ornamental Fish and Aquarium Management / Statistics and Bioinformatics/)

MJDSE-03: Ornamental Fish and Aquarium Management **Credits 04 (FM:75)**

Course outcome:

Students will gain comprehensive knowledge of the importance and scope of the ornamental fish industry, along with an understanding of the diversity of freshwater and marine ornamental fish species, including popular indigenous and exotic varieties. They will develop skills in breeding, larval rearing techniques, and nutritional management using formulated and live feeds. The course will enable students to design, construct, and manage aquaria, incorporating suitable plants, equipment, and decorative materials. Furthermore, students will be able to apply scientific and entrepreneurial principles in ornamental fish culture, aquarium maintenance, and marketing for sustainable enterprise development.

MJDSE-03T: Ornamental Fish and Aquarium Management (Theory) *Credits 03 (45 hrs)*

Course Content:

Importance and scope of ornamental fish. Diversity of freshwater and marine ornamental fish species. Popular indigenous and exotic species. Breeding and larval rearing methods. Formulated, live feed and nutrition. Types and designs of aquaria. Aquarium construction, equipment and accessories. Aquarium plants, accessories, decorative materials. Aquarium management. Entrepreneurship opportunities in ornamental fish culture and aquarium management. Ornamental fish marketing.

MJDSE-03P: Ornamental Fish and Aquarium Management (Practical) *Credits 01 (30 hrs)*

1. Identification of common freshwater and marine ornamental fishes
2. Identification of aquarium plants and decorative materials.
3. Designing and construction of aquarium.
4. Water quality parameters and management
5. Aquarium maintenance: cleaning, water exchange, stocking density.
6. Breeding of freshwater ornamental fishes
7. Preparation and feeding of live feed
8. Observation of ornamental fish diseases and treatment methods.
9. Field visit

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Suggested Readings:

1. Chakraborty, B. K. & Bhattacharjee, S. (2010). *Ornamental Fish: Breeding, Culture and Marketing.* Narendra Publishing House, New Delhi.
2. James, P. S. B. R. (Ed.) (2003). *Handbook on Aquafarming: Ornamental Fishes.* Marine Products Export Development Authority (MPEDA), Cochin.
3. MPEDA (Marine Products Export Development Authority) (2011). *Ornamental Fish Breeding and Culture: A Practical Manual.* MPEDA, Cochin.
4. Qureshi, T. A. & Qureshi, N. A. (2016). *Ornamental Fish Culture and Aquarium Management.* Biotech Books, New Delhi.
5. Saxena, A. (2014). *Aquarium Fishes and Ornamental Fish Culture.* Daya Publishing House, New Delhi.
6. Swain, S. K. & Das, R. C. (2010**).** *Ornamental Fish Breeding, Culture and Trade.* Narendra Publishing House, New Delhi.
7. Vivekanandan, E. & Jayasankar, P. (2008). *Marine Ornamental Fishes of India.* Central Marine Fisheries Research Institute (CMFRI), Cochin.

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MJDSE-03: Statistics and Bioinformatics **Credits 04 (Full Marks: 75)**

MJDSE-03T: Statistics and Bioinformatics (Theory) *Credits 04 (60 hrs)*

Course outcome:

Apply statistical methods to analyse and interpret the biological data. Represent the data of experimental and field studies through graphs and diagrams. Understand statistical concepts and learn to use a variety of statistical tests. Know how to use bioinformatics for DNA and protein sequence analysis through bioinformatics tools and databases. Understand microarray technique for gene expression analysis. Application of ICT and AI in the aquaculture field.

Course Content:

Statistics: Frequency distribution; Variance; Histogram; Pie diagram; Bar diagrams and Frequency curves. Concept of sample and population. Mean; Median; Mode; Standard Deviation (SD), and Standard Error of Mean (SEM). Normal and binomial distribution. Scope and objectives of fisheries statistics. Sample; Survey; Probability calculation; Chi-squire (X2) test; Test of significance; ANOVA; Linear regression and correlation. Analysis of Variance. Fitting curves and index numbers. Statistical analysis of biological data. Identification of problem and formulation of objectives and hypotheses. Types of hypotheses. Testing of the hypothesis. Variables, data types: qualitative, quantitative; Experimental design. Application of statistical methods in Research. Use of tables, graphs, diagram, etc. in reports using computers.

Bioinformatics: Introduction and scope of Bioinformatics. Concepts, brief history and its role and importance in fisheries and aquaculture. Field of application and common biological database. Major Bioinformatics resources; Knowledge of various database. Important bioinformatics tools used in fisheries and aquaculture. Computational analyses of genomes and proteomes. Basic concepts in computational phylogenetic analysis. Role of ICT in Aquaculture sector. AI in aquafarming.

Suggested readings:

1. Bhatt B. R., Srivenkatramana T. and Rao Madhva K. S. (1996): Statistics: A Beginner's
1. Text, Vol 1, and New Age International (P) Ltd.
2. Goon A. M., Gupta M. K. Das Gupta B. (1991): Fundamentals of Statistics. Vol 1, World
3. Press, Calcutta. Additional References.
4. Anderson T. W. and Sclove S. L. (1978): An Introduction to Statistical Analysis of Data, Houghton Mffin Co.
5. Snedecor G.W. and Cochran W.G. (1967): Statistical Methods. Iowa State University Press.
6. Spiegel M. R. (1967): Theory and Problems of Statistics, Schaum's Publishing Series.
7. Das. N. G (1996), *Statistical* Methods, M. *Das* & Co. (Ca1cutta).

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8. Das D. and Das A. (2005). Statistics in Biology and Psychology. Academic Publishers, Kolkata.
9. Bioinformatics: Sequence and Genome Analysis by Mount D., Cold Spring Harbor Laboratory Press, New York. 2004.
10. Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., Wiley India Pvt Ltd. 2009.
11. Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith. Pearson Education. 1999.

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MJDSE-03: Remote Sensing & GIS **Credits 04 (Full Marks: 75)**

MJDSE-03T: Remote Sensing & GIS (Theory) *Credits 04 (60 hrs)*

Course outcome:

Students will acquire an in-depth understanding of the principles and operational mechanisms of Remote Sensing, GIS, and GPS, and their relevance to fisheries and aquaculture systems. They will develop the competence to interpret and analyze spatial and satellite data for fisheries forecasting, conservation, and sustainable management of aquatic resources. The course will enable students to apply geospatial tools in coastal resource assessment, aquaculture planning, and environmental monitoring. Furthermore, learners will gain insights into disaster vulnerability, evaluate the impacts of natural and anthropogenic hazards, and design geospatially informed strategies for disaster mitigation and enhancement of sea safety..

Course Content:

Definition and principles of Remote Sensing and GIS. Sensing mechanism. Analysis of images and data. Fisheries forecasting system. Global Positioning System (GPS). Application of Remote Sensing & GIS in conservation, management of fish faunal diversity and exploitation of capture fisheries. Application of Remote Sensing and GIS in coastal resource management and aquaculture. Basic concepts of disaster vulnerability in India. Different ways of detecting and predicting disasters. Natural and manmade hazards' impact on the fisheries and aquaculture sector in India. Pre-disaster prevention and post-disaster management in the aquaculture sector. Measures to enhance sea safety.

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Minor (MI)-07: Ornamental Fish and Aquarium Management Credits 04 (FM:75)

Course outcome:

Students will gain comprehensive knowledge of the importance and scope of the ornamental fish industry, along with an understanding of the diversity of freshwater and marine ornamental fish species, including popular indigenous and exotic varieties. They will develop skills in breeding, larval rearing techniques, and nutritional management using formulated and live feeds. The course will enable students to design, construct, and manage aquaria, incorporating suitable plants, equipment, and decorative materials. Furthermore, students will be able to apply scientific and entrepreneurial principles in ornamental fish culture, aquarium maintenance, and marketing for sustainable enterprise development.

MI-07T: Ornamental Fish and Aquarium Management (Theory) *Credits 03 (45 hrs)*

Course Content:

Importance and scope of ornamental fish. Diversity of freshwater and marine ornamental fish species. Popular indigenous and exotic species. Breeding and larval rearing methods. Formulated, live feed and nutrition. Types and designs of aquaria. Aquarium construction, equipment and accessories. Aquarium plants, accessories, decorative materials. Aquarium management. Entrepreneurship opportunities in ornamental fish culture and aquarium management. Ornamental fish marketing.

MI-07P: Ornamental Fish and Aquarium Management (Practical) *Credits 01 (30 hrs)*

10. Identification of common freshwater and marine ornamental fishes
11. Identification of aquarium plants and decorative materials.
12. Designing and construction of aquarium.
13. Water quality parameters and management
14. Aquarium maintenance: cleaning, water exchange, stocking density.
15. Breeding of freshwater ornamental fishes
16. Preparation and feeding of live feed
17. Observation of ornamental fish diseases and treatment methods.
18. Field visit

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Suggested Readings:

8. Chakraborty, B. K. & Bhattacharjee, S. (2010). *Ornamental Fish: Breeding, Culture and Marketing.* Narendra Publishing House, New Delhi.
9. James, P. S. B. R. (Ed.) (2003). *Handbook on Aquafarming: Ornamental Fishes.* Marine Products Export Development Authority (MPEDA), Cochin.
10. MPEDA (Marine Products Export Development Authority) (2011). *Ornamental Fish Breeding and Culture: A Practical Manual.* MPEDA, Cochin.
11. Qureshi, T. A. & Qureshi, N. A. (2016). *Ornamental Fish Culture and Aquarium Management.* Biotech Books, New Delhi.
12. Saxena, A. (2014). *Aquarium Fishes and Ornamental Fish Culture.* Daya Publishing House, New Delhi.
13. Swain, S. K. & Das, R. C. (2010**).** *Ornamental Fish Breeding, Culture and Trade.* Narendra Publishing House, New Delhi.
14. Vivekanandan, E. & Jayasankar, P. (2008). *Marine Ornamental Fishes of India.* Central Marine Fisheries Research Institute (CMFRI), Cochin.

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SEMESTER-VIII

MAJOR (MJ)

MJ-16: Genetics, Breeding and Hatchery Management **Credits 04 (FM:75)**

Course outcome:

After successful completion of the theoretical and practical components of this course, students will develop a sound understanding of genetic principles and their applications in fish breeding, hatchery management, and quality seed production. They will benefit by acquiring the ability to apply scientific breeding approaches for stock improvement and sustainable aquaculture practices. Practical training will enhance their skills in broodstock management, induced breeding, larval rearing, hatchery operation, and seed handling. Students will also gain competencies in hatchery design and construction, biosecurity management, reproductive health assessment, and maintenance of seed quality standards. Exposure to genetic analysis and gamete preservation techniques will strengthen their research and technical capabilities. The course will prepare students for professional careers in aquaculture, hatchery enterprises, and fish seed industries, while also enabling them to become successful entrepreneurs through the establishment and management of modern hatchery units.

MJ-16T: Genetics, Breeding and Hatchery Management (Theory) *Credits 03 (45 hrs.)*

Course Contents:

Principles of Genetics and Breeding. Fish genetic resources. Gene bank. Cytogenetics and evolution. Application of genetics and hormones in fish seed upgradation. Monosex population, sex reversal and sterility. Historical development of fish breeding. Natural breeding, bundh breeding, artificial breeding and seed production of commercially important finfish and shellfishes. Fish Breeding Plans. Broodstock management. Hypophysation technique. Inducing agents used for induced breeding. Sympathetic breeding. Multiple breeding. Breeding techniques for major aquarium fishes. Types of eggs, embryonic development, and larvae in fishes. Preservation of gametes. Types of hatchery. Criteria for site selection of hatchery. Design and construction of modern hatchery. Operation, management and hatchery technology for seed production of finfish and shell fish species. Bio-security measures. Seed quality and fish seed certification. Anesthetics and sedatives used. Seed packaging and transportation methods. Economics of seed production.

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MJ-16P: Genetics, Breeding and Hatchery Management (Practical) *Credits 01 (30 hrs.)*

Course Outline:

- Identification of sexual dimorphic characters in cultivable fishes.
- Application of various computer software for genetic analyses.
- Breeding and larval care of finfish and shellfishes.
- Hypophysation techniques.
- Hormone induced breeding.
- Assessment of gamete quality.
- Assessment of gonadal maturity stages.
- Histology and histochemistry of fish gonads and related organs.
- Cryopreservation
- Study of hatchery layout and components.
- Cryopreservation of fish gametes.
- Live feed culture (Moina/Rotifer/Artemia/tubifex/others)
- Spawn, fry and fingerling identification.
- Seminar talk

Suggested reading:

1. Handbook of Fisheries and Aquaculture. ICAR Publication New Delhi, 2016
2. Breeding and Seed Production of Fin Fish and Shell Fish by Thomas, Rath & Mohapatra. Daya Publishers, New Delhi. 2014.
3. Induced Fish Breeding: A Practical Guide for Hatcheries by N.R. Chattopadhyay. Academic Press. 2016.
4. Text Book of Breeding and Hatchery Management of Carps. NPH, New Delhi. 2008
5. Cryopreservation of Fish Gametes by Betsy & Kumar. Springer. 2020.

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Major Elective – 04:

(Aquatic Microbiology OR *Fisheries Engineering)*

MJDSE-04: Aquatic Microbiology **Credits 04 (Full Marks:75)**

Course outcome:

After completing this course, students will be able to understand microbial diversity and functions in aquatic ecosystems. Apply microbial concepts in aquaculture and fisheries management. Analyze microbial roles in water quality and fish health. Integrate microbiological knowledge with sustainable aquaculture.

MJDSE-04T: Aquatic Microbiology (Theory) *Credits 03 (45 hrs)*

Course Content:

Introduction and scope of aquatic microbiology. Influence of physico-chemical and biological factors on aquatic micro-organisms. Growth and reproduction of bacteria, microbial population in relation to physical, chemical and biological characteristics in ponds Microbial growth and its measurement. Types of media used for isolation and enumeration of aquatic microorganisms. Different culture techniques. Methods for identification of aquatic microbes (morphological, cultural, biochemical and molecular approach). Sampling, isolation and purification of major groups of microbes from culture ecosystems. Methods of Pathogenic bacteria in culture systems and control measures. Concept of probiotics and prebiotics in aquaculture. Microbial biofilms and its significance. Microbial bioremediation and bio-augmentation. Role of microbes in biogeochemical cycle. Harmful algal blooms (HABs) and microbial contamination. Microbial biotechnology applications in fisheries, waste recycling, biofloc technology.

MJDSE-04P Aquatic Microbiology (Practical) *Credits 01 (30 hrs)*

- Instruments used in microbiology laboratory
- Sterilization technique- dry heating, autoclaving
- Different types of media preparation.
- Isolation of bacteria from fishes and water.
- Different staining process of bacteria.
- Enumeration of bacteria by TPC method
- Enumeration of total coliforms (MPN technique)
- Study of microbial succession in culture water
- Demonstration of biofilm formation

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- Microbial fermentation technique
- Seminar talk

Suggested Readings:

1. Aquatic Microbiology and Biotechnology, Authors: D. Prasanna Kumar, P. Usha Rani, K. Venkateswarulu, Publisher: Narendra Publishing House, New Delhi, ISBN: 9789389540836 2.
2. Microbiology of Aquatic Systems, Authors: K. Ramakrishna Rao, K. R. Sambasiva Rao, Publisher: Scientific Publishers, Jodhpur, ISBN: 9789386237807
3. Aquatic Microbial Ecology and Biogeochemistry, Authors: K. Ramaiah, R. Nagendra Prasad, Publisher: Daya Publishing House, New Delhi
4. Fish and Shellfish Pathology, Authors: B. K. Mishra, B. K. Pradhan, Publisher: Narendra Publishing House, New Delhi
5. Methods in Aquatic Microbiology, Authors: S. K. Das, A. K. Rath, Publisher: Daya Publishing House, New Delhi
6. Biofloc Technology – A Practical Guide Book, Authors: Y. Avnimelech, Publisher: World Aquaculture Society (Indian Edition available)

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MJDSE-04: Fisheries Engineering **Credits 04 (Full Marks: 75)**

Course Outcomes:

After completing this course, students will be able to understand engineering fundamentals for fisheries and aquaculture systems, including fisheries technology progression and current infrastructure construction. It teaches how to plan, and manage fishing harbors, vessels, gears, and navigation systems for safety and efficiency. Students learn fish detection, underwater acoustics, and navigation, refrigeration and cold chain systems for fish handling, preservation, and processing. Students learn to construct ponds, tanks, RAS, aeration, filtration, and water management systems. Integration of automation, pump selection, and sterilizing improves system efficiency and sustainability. Use engineering and technology to build sustainable fisheries and aquaculture.

MJDSE-04T: Fisheries Engineering (Theory) *Credits 03 (45 hrs)*

Course Content:

Introduction to engineering principles as applied to fisheries, evolution of fisheries technology. Planning and management of fishing harbours including layout, facilities, dredging, dry docks, vessel mooring systems, and logistics, Study of types of fishing vessels, their design material, Types of fishing gears, their components, selection criteria and material characteristics. Introduction to fish finders, sonar, and underwater acoustics for locating fish schools. Fundamentals of refrigeration and cold chain systems applications in fish handling and processing, and refrigeration on factory vessels. Core navigation principles for small and mechanized craft, distress signals. Engineering aspects of aquaculture infrastructure: site selection, surveying & leveling, design of ponds, raceways and tanks, water conveyance systems, flow measurement, recirculating aquaculture systems (RAS), aeration systems, filtration units, pump selection, sterilization techniques, and automation.

MJDSE-04P Fisheries Engineering (Practical) *Credits 01 (30 hrs)*

- Identification of fishing gears and crafts
- Modelling of fishing gear
- Material testing for nets and components
- Design and layout of aquafarms.
- Vessel monitoring system.
- Seminar talk
- Field visit

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Suggested reading:

1. A Textbook on Aquaculture Engineering, Authors: Rabinarayan Mishra & K.C. Dora, Publisher: Narendra Publishing House, New Delhi
2. Modern Fisheries Engineering, Editors: Stephen A. Bortone & Shinya Otake, Publisher: CRC Press (Taylor & Francis Group)
3. Aquaculture Machineries and Equipment, Authors: Mohammad Tanveer, R. Pradeep & S.
4. Ayesha Jasmin, Publisher: NIPA Publications
5. Innovations in Fishing and Fish Processing Technologies, Editors: C.N. Ravishankar et al., Publisher: NIPA Publications
6. Fisheries Engineering and Technology, Author: Joel Prado, Publisher: UNESCO – EOLSS

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MAJOR ELECTIVE- 05

[to be studied by Honours students only]

MJDSE-05: ICT and AI Application in Fisheries **Credits 04 (Full Marks: 75)**

Course outcome:

Upon completion of the course, students will be able to: Understand ICT and AI concepts relevant to fisheries science, apply digital tools for fisheries and aquaculture management, analyze fisheries data using ICT-based systems, Integrate AI technologies for sustainable and precision fisheries

MJDSE-05T: ICT and AI Application in Fisheries (Theory) *Credits 03 (45 hrs)*

Course Content:

Concept, evolution, and scope of ICT and AI in fisheries and aquaculture. Overview of smart fisheries, digital aquaculture, and precision management. Application of ICT and AI based software like Python and etc. ICT infrastructure for fisheries research. Types of fisheries and aquaculture data: biological, environmental, production, socioeconomic, and spatial data. Data collection methods, digitization, storage, retrieval, and visualization. Use of satellite data for productivity, climate monitoring, and resource planning. Application of DSS in aquaculture management, stock assessment, disease forecasting, and farm planning. Basic concepts of artificial intelligence, machine learning, and deep learning. AI-based farm management and productivity enhancement. Application of AI for early disease detection, pattern recognition, and risk assessment. Basics concept of image processing and computer vision and applications in species identification, biomass estimation, size grading, behavior analysis, and quality assessment. Concept of IoT and smart sensing systems. Role of ICT in knowledge dissemination, farmer advisories, and capacity building. Mobile apps, web portals, and digital platforms for fisheries extension. Use of ICT and AI in climate impact assessment, vulnerability mapping, and adaptive fisheries management. Future scope of AI-enabled fisheries science.

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MJDSE-05P: ICT and AI Application in Fisheries (Practical) *Credits 01 (30 hrs)*

- Familiarization with fisheries-related ICT tools and software
- Introduction to GIS mapping for fisheries applications
- Demonstration of sensor-based water quality monitoring
- Case studies on AI use in aquaculture and fisheries
- Data visualization and basic analytics for fisheries datasets
- Exposure to mobile apps and digital advisory platforms
- Software

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Suggested reading:

1. ICT Applications in Fisheries and Aquaculture, Authors: S. Sathiadhas, K. K. Philipose, P. P. Manojkumar, Publisher: ICAR–Central Marine Fisheries Research Institute (CMFRI), Kochi
2. Geographic Information System and Remote Sensing in Fisheries, Authors: V. Venkatesan, K. S. Mohamed, Publisher: Narendra Publishing House, New Delhi
3. Artificial Intelligence and Machine Learning for Aquaculture, Authors: C. Sathish Kumar, R. Suresh, Publisher: Apple Academic Press (CRC Press – Indian Edition)
4. Internet of Things and Smart Aquaculture, Authors: S. R. Singh, M. K. Jha, Publisher: Scientific Publishers, Jodhpur
5. Decision Support Systems in Agriculture and Fisheries, Authors: R. K. Singh, P. K. Mishra, Publisher: New India Publishing Agency, New Delhi
6. Digital Image Processing and Computer Vision, Authors: Rafael C. Gonzalez, Richard E. Woods, Publisher: Pearson India

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MJDSE-05: Bee Keeping and Management **Credits 04 (Full Marks: 75)**

MJDSE-05T: ***Bee Keeping and Management*** *(Theory)* *Credits 03 (45 hrs)*

Course Content:

Unit	Topic
1	**Introduction to Apiculture:** History and Scope: The transition from honey hunting to organized beekeeping; status of the beekeeping industry in India. Bee Diversity: Systematic position and identification of major honey bee species: *Apis dorsata* (Rock bee), *Apis florea* (Little bee), *Apis cerana indica* (Indian bee), *Apis mellifera* (European bee - commercial standard). Social Organization: The "Superorganism" concept; differentiation of castes (Queen, Drone, and Worker) and their specific duties.
2	**Bee Biology and Communication:** Basic external morphology (specialized structures like pollen baskets and wax glands). Life Cycle: Developmental stages and lifespan of different castes. Communication: The dance language of bees (Round dance and Waggle dance) for foraging efficiency. Flora and Forage: Identifying "Bee Pasturage" (nectar and pollen-yielding plants) and their flowering phenology.
3	**Apiary Equipment and Management:** The Modern Hive: Detailed study of the Lang troth Hive and Newton Hive; components (Bottom board, brood chamber, super, frames, and inner cover). Beekeeping Tools: Smokers, bee veils, gloves, hive tools, and honey extractors. Seasonal Management: Spring/Summer: Managing swarming and honey flow. Monsoon: Supplemental feeding and protection from moisture. Winter: Insulation and colony merging.
4	Bee Health and Protection: Infectious Diseases: Bacterial (American/European Foulbrood), Viral (Sacbrood), and Fungal (Chalkbrood) diseases. Pests and Predators: Management of Wax Moths, Varroa mites, wasps, and birds. Pesticide Safety: Understanding the impact of neonicotinoids and agrochemicals on bee health; "Bee-friendly" farming practices.
5	**Economics and Value Addition: Bee Products:** Composition and uses of Honey, Beeswax, Royal Jelly, Propolis, Bee Venom, and Pollen. **Pollination Services:** The economic value of bees in increasing crop yields (e.g., mustard, sunflower). **Entrepreneurship:** government schemes (National Beekeeping & Honey Mission - NBHM); FSSAI standards for honey quality.

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MJDSE-05P: ***Bee Keeping and Management*** *(Practical)* *Credits 01 (30 hrs)*

List of Practical:

Suggested reading:

1. "The ABC and XYZ of Bee Culture" by A.I. Root.
2. "Beekeeping in India" by S. Singh (ICAR Publication).
3. "Textbook of Applied Entomology" (Vol. II) by K.P. Srivastava.
4. "Prosperous Beekeeping" by R.C. Misra.

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MAJOR ELECTIVE- 06

[to be studied by Honours students only]

MJDSE-06: Modern Aquaculture Technology **Credits 04 (Full Marks: 75)**

Course outcomes:

The focused area of this unit is aquaculture practices which are the most important areas of aquaculture sectors and major recruitment took place in this areas especially in corporate house. Students will understand modern aquaculture technologies, production systems, and emerging trends in fish and shellfish farming. They will develop practical skills in soil and water quality analysis, farm design, and culture techniques. The course will enhance knowledge of integrated and sustainable farming practices, use of modern instruments, and management of environmental impacts, preparing students for advanced aquaculture operations and entrepreneurship

MJDSE-06T: Modern Aquaculture Technology (Theory) *Credits 03 (45 hrs)*

Course Content:

Present status, problems and scope of fish and prawn farming in global and Indian perspective. Farming of commercially important finfish and shellfishes. Wastewater-fed aquaculture. Intensification of aquaculture and technological innovation in pond, tank, pen and cage culture. Hi-tech aquaculture production system: Integrated Multi-Trophic Aquaculture (IMTA), Aquaponics, Soft Shell Crab Farming (vertical farming system/apartment farming system), Recirculating Aquaculture System (RAS), Organic farming and Biofloc culture, Partitioned Aquaculture Systems (PAS), In-Pond Raceway Systems (IPRS), Vertical and Aquamimicry systems. Different integrated farming systems (fish with paddy, cattle, pig, poultry, duck, rabbit etc.). Mariculture, Seaweed culture; emerging trends in their farming in open seas. Physical and chemical properties of soil and water. Modern instruments used for measuring water and soil quality. Soil and water quality standards for aqua farming. Different kinds of fertilizers, Bio fertilizers and manures and their application and their impact on environment. Guidelines of sustainable aquaculture.

MJDSE-06P: Modern Aquaculture Technology (Practical) *Credits 01 (30 hrs)*

- Determination of soil texture, Organic Carbon, Phosphorus, Potassium, Nitrogen, C/N
- ratio, pH etc.
- Study of the physico-chemical characteristics of water: pH, Temperature, Dissolved oxygen,

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- Productivity, Free CO2, Hardness, Salinity, Alkalinity, Transparency, Turbidity etc.
- Identification of different macrophytes collected from freshwater ecosystem.
- Study of benthic community, aquatic insects from different aquatic ecosystems.
- Analysis of phytoplankton and zooplankton from different aquatic ecosystems
- Design and layout of different aquaculture farm.
- Design and constructions of pond, pen, cage, Biofloc unit etc.
- Collection and identification of fish food organisms.
- Visit to aqua farm / Modern aquafarming system

Suggested Readings:

1. Adhikari S and Chatterjee DK. 2008. *Management of Tropical FreshwaterPonds*. Daya Publ.
2. APHA, AWWA, WPCF. 1998. Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, Washington, DC.
3. Boyd, C. E. and Tucker, C. S. 1992. *Water Quality and Pond Soil Analyses 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.
6. Mcvey JP. 1983. *Handbook of Mariculture*. CRC Press.
7. Parsons TR, Maita Y and Lalli CM. 1984. *A Manual of Chemical and Biological Methods for Seawater Analysis*. Pergamon Press.
8. Rajagopalsamy CBT and Ramadhas V. 2002. *Nutrient Dynamics inFreshwater Fish Culture System*. Daya Publ.
9. Bardach JE. 1997. *Sustainable Aquaculture*. John Willey and Sons.
10. Bardach JE, Rhyther JH and Mc. Larney WO. 1972. *Aquaculture Farming and Husbandry of Freshwater and Marine Organisms*. John Wiley and Sons.
11. Beets WC. 1990. *Raising and Sustaining Productivity of Small- Holder Farming Systems in the Tropics*. Agbe Publ.
12. Edwards P, Little DC and Demaine H. (Eds.). 2002. *Rural Aquaculture*. CABI.
13. FAO 2001. *Planning and Management for Sustainable Coastal Aquaculture Development*. FAO.

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PROJECT / DISSERTATION (RD)

[to be undertaken by students opting for and eligible for Hons. with Research]

DISSERTATION:
Credit: 8; Full Marks: 150

Structure of the dissertation

Preliminary Pages

- Title Page: Includes name of the student, university, degree, and submission date.
- Certificate/Declaration: Signed statement of originality and supervisor's approval
- Abstract: A 250-350 word summary covering research problem, methodology, and core findings.
- Acknowledgements: To supervisors and others, if any.
- Table of Contents: Clear hierarchical mapping of chapters with page number
- List of Abbreviations: Specialized terms, if any

Introduction

- Background & Context: Situates the topic in historical or theoretical context.
- Research Problem & Objectives: The specific question or gap the research is addressing.
- Thesis Statement/Hypothesis: The core argument the dissertation intends to prove.
- Scope and Significance: Why the study matters.
- Literature Review & Theoretical Framework

Literature Review: Analyzes existing scholarly works to show the gap the study fills.

- Theoretical Framework: Identifies the philosophers, critics, or schools of thought shaping the analysis in the dissertation.

Methodology

- Describes *how* the research was conducted - Anyone or a combination of textual analysis/ archival research/ conducting interviews/ ethnographic/semi-ethno-graphic research involving both textual analysis and field visit etc.
- Thematic or Analytical Chapters

The Core Body: Usually 3 to 4 chapters focusing on the core concerns of the study.

- Structure: Each chapter introduces its specific theme, analyzes primary and secondary sources, and contributes to the overarching thesis.

Conclusion

- Summary & Synthesis: Recaps your main points without simply repeating them.

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Final Verdict: Answers the research questions posed in the introduction.

Future Scope: Suggests how future scholars can build upon your work.

- Works Cited/ Reference, and/or Bibliography: A comprehensive list of all primary and secondary sources cited as per the latest MLA style.

Appendices: Transcripts, interview logs, or raw archival data, if any.

Marks distribution-

Sl. No	Particulars	Marks
1	Research Project / Dissertation Report	70
	▪ Proposal and Abstract (along with some keywords)	10
	▪ Literature Review &Theoretical Framework	10
	▪ Methodology and Research design	10
	▪ Thematic Analysis (Chapter-wise)	20
	▪ Report Quality	20
2	Seminar Presentation	30
3	Viva-Voce	50
Total		**150**

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MINOR (MI)

Minor (MI)-08: Genetics, Breeding and Hatchery Management Credits 04 (FM: 75)

Course outcome:

After successful completion of the theoretical and practical components of this course, students will develop a sound understanding of genetic principles and their applications in fish breeding, hatchery management, and quality seed production. They will benefit by acquiring the ability to apply scientific breeding approaches for stock improvement and sustainable aquaculture practices. Practical training will enhance their skills in broodstock management, induced breeding, larval rearing, hatchery operation, and seed handling. Students will also gain competencies in hatchery design and construction, biosecurity management, reproductive health assessment, and maintenance of seed quality standards. Exposure to genetic analysis and gamete preservation techniques will strengthen their research and technical capabilities. The course will prepare students for professional careers in aquaculture, hatchery enterprises, and fish seed industries, while also enabling them to become successful entrepreneurs through the establishment and management of modern hatchery units.

MI-08T: Genetics, Breeding and Hatchery Management (Theory) *Credits 03 (45 hrs.)*

Course Contents:

Principles of Genetics and Breeding. Fish genetic resources. Gene bank. Cytogenetics and evolution. Application of genetics and hormones in fish seed upgradation. Monosex population, sex reversal and sterility. Historical development of fish breeding. Natural breeding, bundh breeding, artificial breeding and seed production of commercially important finfish and shellfishes. Fish Breeding Plans. Broodstock management. Hypophysation technique. Inducing agents used for induced breeding. Sympathetic breeding. Multiple breeding. Breeding techniques for major aquarium fishes. Types of eggs, embryonic development, and larvae in fishes. Preservation of gametes. Types of hatchery. Criteria for site selection of hatchery. Design and construction of modern hatchery. Operation, management and hatchery technology for seed production of finfish and shell fish species. Bio-security measures. Seed quality and fish seed certification. Anesthetics and sedatives used. Seed packaging and transportation methods. Economics of seed production.

MI-08P: Genetics, Breeding and Hatchery Management (Practical) *Credits 01 (30 hrs.)*

Course Outline:

- Identification of sexual dimorphic characters in cultivable fishes.
- Application of various computer software for genetic analyses.
- Breeding and larval care of finfish and shellfishes.

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- Hypophysation techniques.
- Hormone induced breeding.
- Assessment of gamete quality.
- Assessment of gonadal maturity stages.
- Histology and histochemistry of fish gonads and related organs.
- Cryopreservation
- Study of hatchery layout and components.
- Cryopreservation of fish gametes.
- Live feed culture (Moina/Rotifer/Artemia/tubifex/others)
- Spawn, fry and fingerling identification.
- Seminar talk

Suggested reading:

1. Handbook of Fisheries and Aquaculture. ICAR Publication New Delhi, 2016
2. Breeding and Seed Production of Fin Fish and Shell Fish by Thomas, Rath & Mohapatra. Daya Publishers, New Delhi. 2014.
3. Induced Fish Breeding: A Practical Guide for Hatcheries by N.R. Chattopadhyay. Academic Press. 2016.
4. Text Book of Breeding and Hatchery Management of Carps. NPH, New Delhi. 2008
5. Cryopreservation of Fish Gametes by Betsy & Kumar. Springer. 2020.

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