Vidyasagar University
Midnapore-721102, West Bengal

The draft SYLLABUS for

M.Sc.

in

FISHERIES SCIENCE

[w.e.f. 2025-26]

PREAMBLE

Fisheries sector plays an important role in the socio-economic development of the country in view of its potential contribution to national income, food security, social objectives and sustainable large export earnings. India's future fisheries development plans aim at increasing fish production, improving the welfare of fishermen, promoting export earnings and providing food security. In this context, the trained manpower has been identified as a critical input to fisheries development. The mandate of the Vidyasagar University is to plan, undertake, aid, promote and co-ordinate education, research and extension in Fisheries Science for the livelihood generation of a large section of the region and our university will play a key role in fisheries education and research in the state of West Bengal, in particular and India or outside India in general.

PROGRAM OUTLINES

1. The M.Sc. in Fisheries Science is a regular postgraduate program of two years' duration, organized over four semesters, encompassing a total of 88 credits along with one non-credit course.

2. Each semester carries a total of 275 Marks (22 credits).

    - Semester-I: 07 courses/papers [03 Discipline Specific Core (DSC) Course and 02 Discipline Specific Elective (DSE) Course with 05 theory courses and 01 practical courses and 01 non-credit course].

    - Semester-II: 06 courses/papers (02 DSC, 03 DSE and one Field based course/paper)

    - Semester-III: 4 courses/papers (04 DSC, 01 MOOC course and 01 Community service paper).

    - Semester- IV: 05 DSC Course (2 DSC theoretical, 01 DSC (practical) i.e. 4 weeks Internship (4 credit), a dissertation/Research project course/paper (practical)- 8 credits and one Grant writing and Seminar on Innovation & Incubation/Research/ Entrepreneurship/Start-up - 2 credits.

3. Each core theory course will be assessed through internal evaluation, of 5 marks. The internal assessment for each theory course will be based on a MCQ/written test/seminar presentation.

4. Semester-IV includes two theory-based DSC courses of 4 credits each along with field-oriented internship programs (2 credits) and a dissertation work (8 credits). Each student must complete an 8-credit research project, evaluated through a written report, seminar presentation, and viva-voce. Additionally, a 2-credit DSC course equips students with grant writing skills and seminar presentations focused on innovation, research, entrepreneurship, incubation, or start-up activities.

PROGRAM OUTCOMES

The **M.Sc. in Fisheries Science** program, designed in alignment with the principles of the National Education Policy (NEP) 2020**,** aims to nurture skilled, innovative, and socially responsible professionals capable of contributing to the sustainable development of the fisheries and aquaculture sectors. The program provides an advanced understanding of finfish and shellfish reproduction, nutrition, genetics, and health management, integrated with modern aquaculture technologies, biotechnology, and aquatic microbiology. Students will gain scientific competence in the use of advanced tools such as Remote Sensing, GIS, ICT, and Artificial Intelligence for fisheries resource assessment, management, and innovation.

The curriculum emphasizes experiential learning through practicals, field visits, internships, and dissertation projects, enabling students to translate theoretical knowledge into real-world applications. Training in research methodology, statistics, and bioinformatics strengthens analytical, problem-solving, and data interpretation skills, while exposure to fisheries engineering, product development, and value addition builds technical proficiency and industrial relevance.

Grounded in the ethos of the Indian Knowledge System (IKS) and inspired by the philosophy of holistic education, the program promotes ethical, inclusive, and sustainable fisheries practices. It also encourages entrepreneurship, innovation, and community engagement, fostering leadership qualities and a commitment to social and environmental responsibility. Graduates will emerge as competent researchers, academicians, and entrepreneurs capable of addressing emerging challenges in fisheries, aquaculture, and allied sectors, thereby contributing to national food security, livelihood enhancement, and the blue economy.

The **Department of Fishery Sciences, Vidyasagar University**, is committed to advancing education, research, and extension in Fisheries Science to support livelihood generation, particularly for the weaker sections of society in the southern region of West Bengal. The course curriculum has been designed to enhance the employability of graduates in both corporate and government sectors. The thrust areas included in the syllabus are: aquatic resources and their management, aquatic environment and climate change, biomechanics, fish physiology and biochemistry, aquatic microbiology and public health fisheries, genetic engineering and biotechnology, fish pathology and disease management, fisheries technology, and harbor engineering. Moreover, the detailed courses in each semester are structured to provide career-oriented knowledge and skills for effective placement in the fisheries sector.

PROGRAM SPECIFIC OUTCOMES

After the successful completion of M. Sc. in Fisheries Science program, the students are expected to:	
PSO1	Develop comprehensive understanding of finfish and shellfish reproduction, genetics, breeding, hatchery management, aquatic microbiology, fish health management, and modern aquaculture technologies, enabling the application of theoretical knowledge to practical fisheries challenges.
PSO2	Acquire proficiency in laboratory techniques, field-based practices, and hands-on aquaculture operations, including the use of biotechnological tools, bioinformatics, ICT, and AI applications, to conduct experiments and solve complex problems in fisheries science.
PSO3	Design and implement aquatic animal nutrition programs, manage fish health, and apply therapeutic measures for disease prevention and control, contributing to sustainable aquaculture production.
PSO4	Capable of utilizing fisheries engineering tools, remote sensing, GIS, and statistical methods for monitoring, analysis, and optimization of aquaculture systems, ensuring evidence-based decision-making and efficient resource management.
PSO5	To be skilled to develop fish products, implement value addition and packaging strategies, understand fisheries economics, marketing, policies, and trade, and promote entrepreneurship and extension services in the fisheries sector.
PSO6	Develop research aptitude, including experimental design, data analysis, report writing, grant preparation, and ethical conduct in research, fostering innovation and integrity in fisheries science.
PSO7	Acquire indigenous knowledge systems, ethical considerations, and societal responsibilities, integrating sustainable practices and community engagement into fisheries management and policy implementation.

M.Sc. in Fisheries Science

(For the students admitted during the academic year 2025 - 26 onwards)

Semester	Course Code	Title of the Course	Credits (L-T-P)	Maximum Marks		
				IA	End Semester Exam	Total
M. Sc. 1st Year						
Semester -I	**FSCC401X1**	Reproduction in Finfish & Shellfish	2 (1-1-0)	05	20	25
	FSCC401X8	Practical	2 (0-0-2)	-	25	25
	FSCC402X1	Advanced Aquatic Animal Nutrition	2 (1-1-0)	05	20	25
	FSCC402X8	Practical	2 (0-0-2)	-	25	25
	FSCC403X0	Research Methodology and Ethics	4 (3-1-0)	10	40	50
	FSCE404A0	Statistics and Bioinformatics	2 (1-1-0)	05	20	25
	FSCE405A0	Remote Sensing & GIS	2 (1-1-0)	05	20	25
	FSCE406A1	Ornamental Fish and Aquarium Management	2 (1-1-0)	05	20	25
	FSCE406A8	Practical	2 (0-0-2)	-	25	25
	FSCO407VC	Indian Knowledge System (IKS)	2 (2-0-0)	05	20	25
	FSCO408NC	Vidyasagar: Life and Philosophy	1	-	50	50
Total (Sem-I)			**22**	**40**	**235**	**275**
Semester -II	**FSCC451X1**	Genetics, Breeding and Hatchery Management	2 (1-1-0)	05	20	25
	FSCC451X8	Practical	2 (0-0-2)	-	25	25
	FSCE452A1	Aquatic Microbiology	2 (1-1-0)	05	20	25
	FSCE452A8	Practical	2 (0-0-2)	-	25	25
	FSCE453A1	Fisheries Engineering	2 (1-1-0)	05	20	25
	FSCE453A8	Practical	2 (0-0-2)	-	25	25
	FSCE454A1	ICT and AI Application in Fisheries	2 (1-1-0)	05	20	25
	FSCE454A8	Practical	2 (0-0-2)	-	25	25
	FSCC455X1	Modern Aquaculture Technologies	2 (1-1-0)	05	20	25
	FSCC455X8	Practical	2 (0-0-2)	-	25	25
	FSCC456X9	Field Visit/Industry Visit/ Case Study/ Hands-on Practical	2 (2-0-0)	-	25	25
Total (Sem-II)			**22**	**25**	**250**	**275**
Total: 1st Year of M. Sc. (I + II)			**44**	**65**	**485**	**550**
M. Sc. 2nd Year						

Semester	Course Code	Title of the Course	Credit	Maximum Marks		
				IA	End Semester Exam	Total
Semester -III	**FSCC501X0**	MOOCs	4 (4-0-0)	30	70	100
	FSCC502X1	Therapeutics and Fish Health Management	2 (1-1-0)	05	20	25
	FSCC502X8	Practical	2 (0-0-2)	-	25	25
	FSCC503X1	Fish Product Development, Value Addition and Packaging	2 (1-1-0)	05	20	25
	FSCC503X8	Practical	2 (0-0-2)	-	25	25
	FSCC504X1	Biotechniques and Fish Biotechnology	2 (1-1-0)	05	20	25
	FSCC504X8	Practical	2 (0-0-2)	-	25	25
	FSCC505X0	Fisheries Economics & Marketing	4 (3-1-0)	10	40	50
	FSCC506X9	Social Service/Community Engagement	2 (0-0-2)	-	25	25
	Total (Sem-III)		**22**	**55**	**270**	**325**
Semester -IV	**FSCC551X0**	Fisheries Policies, Laws, International Trade & Intellectual Property Right (IPR)	4 (3-1-0)	10	40	50
	FSCC552X0	Fisheries Extension and Entrepreneurship Development	4 (3-1-0)	10	40	50
	FSCC553X9	Research Project/Dissertation (3 months)	8 (0-0-8)	-	100	100
	FSCC554X9	Internship (4 weeks)	4 (0-0-4)	-	50	50
	FSCC555X9	Project/Research proposal writing and Seminar (Innovation & Incubation/Research/Entrepreneurship/Start-up)	2 (0-0-2)	-	25	25
Total (Sem-IV)			**22**	**20**	**255**	**275**
Total: 2nd Year of M. Sc. (III +IV)			**44**	**75**	**525**	**600**
Total: M. Sc. (2 Years) (I+II+III+IV)			**88**	**140**	**1010**	**1150**

DETAILS OF THE COURSES

Semester- I

FSCC401X1: Reproduction in Finfish and Shellfish (Credit-2; Marks- 25)

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.

FSCC401X8: Practical (Credit-2; Marks- 25)

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

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.

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.

FSCC402X1: Advanced Aquatic Animal Nutrition (Credit-2; Marks- 25)

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.

FSCC402X8: Practical: (Credit-2; Marks- 25)

- 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.

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

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.

FSCC403X0: Research Methodology and Ethics (Credit-4; Marks- 50)

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.

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.

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, Dr.
5. 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.

FSCE404A0: Statistics and Bioinformatics (Credit-2; Marks- 25)

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.

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.

Suggested readings:

1. Bhatt B. R., Srivenkatramana T. and Rao Madhva K. S. (1996): Statistics: A Beginner's 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 Press, Calcutta. Additional References.
3. Anderson T. W. and Sclove S. L. (1978): An Introduction to Statistical Analysis of Data, Houghton Mffin Co.
4. Snedecor G.W. and Cochran W.G. (1967): Statistical Methods. Iowa State University Press.
5. Spiegel M. R. (1967): Theory and Problems of Statistics, Schaum's Publishing Series.
6. Das. N. G (1996), *Statistical* Methods, M. *Das* & Co. (Ca1cutta).
7. Das D. and Das A. (2005). Statistics in Biology and Psychology. Academic Publishers, Kolkata.
8. Bioinformatics: Sequence and Genome Analysis by Mount D., Cold Spring Harbor Laboratory Press, New York. 2004.
9. 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.
10. Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith. Pearson Education. 1999.

FSCE405A0: Remote Sensing & GIS (Credit-2; Marks- 25)

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.

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.

FSCE406A1: Ornamental Fish and Aquarium Management (Credit-2; Marks- 25)

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.

FSCE406A8: Practical: (Credit-2; Marks- 25)

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

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.

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.

FSCO407VC: Indian Knowledge System (IKS): (Credit-2; Marks- 25)

Introduction to Indian Knowledge System (IKS), Indigenous Technical Traditional practice in Fisheries and Aquaculture. Traditional Fish Processing and Preservation. Use of indigenous therapeutics. Documentation, Validation, Conservation, and Dissemination of ITK in fisheries in India in general and West Bengal in particular. Different fishing festival in India. ITK in Fishery technology (craft and gears). Institutions and NGOs in ITK Promotion. Integration of IKS and Modern Technologies. Indian Biological Diversity Acts, National Biodiversity Authority; People's Biodiversity Register (PBR) and preparation process, Access and Benefit Sharing (ABS), Prior Informed Consent (PIC), TRIPS vs. CBD, and IPR-related issues.

Course outcome: Students will develop a comprehensive understanding of the Indian Knowledge System (IKS) and Indigenous Technical Knowledge (ITK) relevant to the fisheries and aquaculture sectors. They will be able to identify, document, and validate traditional fisheries practices, aquaculture systems, and fish processing techniques prevalent in different regions, including West Bengal. The course will enable students to appreciate the role of institutions and NGOs in ITK promotion and to integrate traditional knowledge with modern technological advancements. Learners will also gain insight into biodiversity conservation laws,

People's Biodiversity Registers, Access and Benefit Sharing, and intellectual property rights related to indigenous knowledge.

Suggested readings:

1. Nirmal Kumar, J. I., & Kumar, R. N. (2012). *Indigenous Knowledge in Sustainable Utilization of Natural Resources.* Discovery Publishing House, New Delhi.
2. Sastry, K. V. S. (2022). *Introduction to Indian Knowledge System – Concepts and Applications.* Indian Institute of Technology (IIT) Kharagpur & Bharatiya Vidya Bhavan, New Delhi.
3. ICAR–Central Institute of Fisheries Technology (CIFT) (2014). *Indigenous Technical Knowledge (ITK) in Fisheries: Documentation and Dissemination.* CIFT, Kochi, India.
4. ICAR–Central Institute of Freshwater Aquaculture (CIFA) (2016). *Traditional Aquaculture Practices in India.* CIFA Extension Series, Bhubaneswar.
5. CMFRI (Central Marine Fisheries Research Institute) (2010). *Indigenous Knowledge in Marine Fisheries Sector of India.* CMFRI Special Publication, Kochi.
6. Chattopadhyay, D. N., & Mishra, B. K. (2018). *Indigenous Knowledge and Fisheries Development in India.* Narendra Publishing House, New Delhi.
7. National Biodiversity Authority (NBA) (2013). *People's Biodiversity Register: Guidelines and Format.* NBA, Ministry of Environment, Forest and Climate Change, Government of India, Chennai.
8. National Innovation Foundation – India (NIF) (2015). *Documenting and Promoting Grassroots Innovations and Traditional Knowledge.* NIF, Department of Science and Technology, Government of India, Ahmedabad.
9. Government of India (2002). *The Biological Diversity Act, 2002 and Rules, 2004.* Ministry of Environment, Forest and Climate Change (MoEFCC), New Delhi.
10. Chaudhuri, S. K., & Ghosh, S. K. (2016). *Traditional Fisheries and Indigenous Aquaculture Systems of West Bengal.* Department of Fisheries, Government of West Bengal.

FSCO408NC: Vidyasagar: Life and Philosophy **(Credit-1; Marks-50)**

Section-A

A) Early Life and Education: (3 Classes)
   1. Birth and Lineage
   2. A Journey from Iswar Chandra Bondopadhaya to Iswar Chandra Vidyasagar

B) Vidyasagar and Indian Education: (5 Classes)
   1. The then Indian education system
   2. Vidyasagarian plan for reformation of Indian education- Vidyasagar as teacher,Vidyasagar as writer, planner and reformer of Indian education.

C) Vidyasagar and Women Emancipation: (4 Classers)
   1. Introduction of widow remarriage.
   2. Struggle to stop child marriage.

Section-B

D) Philanthropist Vidyasagar (2 Classes)
    1. Vidyasagar's philanthropy as narrated by others.
E) Vidyasagar : Traditions and modernity (6 Classes)
    1. Tradition.
    2. Modernity.
    3. Vidyasagara as Traditional modernizer.
F) Relevance of Vidyasagarian thoughts and values (4 Classes)
    1. Vidyasagar and the then Society of Bengal.
    2. Lesson for future generations.

Course outcome: Students will be able to understand the life, education and historical context of Ishwar Chandra Vidyasagar. They will be able to analyze Vidyasagar's philosophical principles of rationalism, humanitariasm and social justice to contemporary societal and educational issues.

Suggested readings:

1. Amalesh Tripathi: Vidyasagar: the Traditional Modernizer, Cambridge University Press, 2011.
2. Asok Sen: Iswar Chandra Vidyasagar and His Elusive Milestone, Riddhi-Indian, 28 Beniatola Lane, Cal-9.
3. Vidyasagar o Bangali Samaj, Binoy Ghosh, Orient Blacksoan, 2011.
4. Revisiting Modern Indian Thought: Themes and Perspective, (Ed. S. K. Malik and A. Tomar), Routledge, New York and London, 2022 (First South Asian Edition).
5. Brian A. Hatcher (Trans): Vidyasagar: The Life and After Life of Eminent Indian, Routledge, New Delhi, 2014.
6. Binoy Ghosh: Vidyasagar O Bangali Samaj, Orient Blacksoan, 2011.

Semester- II

FSCC451X1: Genetics, Breeding and Hatchery Management

(Credit-2; Marks- 25 (5+20))

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.

FSCC451X8: Practical (Credit-2; Marks- 25)

- 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

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.

Suggested readings:

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.

FSCE452A1: Aquatic Microbiology (Credit-2; Marks- 25(5+20))

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.

FSCE452A8: Practical (Credit-2; Marks- 25)

- 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
- Microbial fermentation technique
- Seminar talk

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.

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)

FSCE453A1: Fisheries Engineering (Credit-2; Marks- 25 (5+20))

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.

FSCE453A8: Practical (Credit-2; Marks- 25)

- 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

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.

Suggested readings:

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. Ayesha Jasmin, Publisher: NIPA Publications
4. Innovations in Fishing and Fish Processing Technologies, Editors: C.N. Ravishankar et al., Publisher: NIPA Publications
5. Fisheries Engineering and Technology, Author: Joel Prado, Publisher: UNESCO – EOLSS

FSCE454A1: ICT and AI Application in Fisheries (Credit-2; Marks- 25(5+20))

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.

FSCE454A8: Practical (Credit-2; Marks- 25)

- 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

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

Suggested readings:

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

FSCC455X1: Modern Aquaculture Technology: (2 credits; Marks- 25 (5+20))

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.

FSCC455X8: Practical (Credit-2; Marks- 25)

- 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,
- 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

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.

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.

FSCC456X9: Field visit/Industry visit/case study/Hands-on Practical

(Credit-2; Marks- 25)

Semester- III

FSCC501X0: MOOC (Swayam Platform) (Credit-4; Marks- 100 (30+70))

FSCC502X1: Therapeutics and Fish Health Management (Theory)

(Credit-2; Marks- 25 (5+20))

Host-pathogen- environment relationship. Host-parasite interaction; Principles of disease diagnosis. Causative agents, symptoms, prophylaxis and treatment studies of viral, bacterial fungal diseases of freshwater, saline water finfishes, shellfishes. Non infectious diseases of fish and shell fishes. Study the Life cycle, symptoms, prophylaxis and possible treatment of of crustacean, helminthes, protozoon and metazoan parasites observed in freshwater and saline water fishes and shell fishes. Immunology: Prevention and control of different fish and shellfish diseases. Antigen-antibody interactions. Different types of immunoglobulins with special emphasis on fish. Cells and organs involved in the immune system in fish. Innate and adaptive immunity. Humoral and Cell mediated immunity. Principles and methods of vaccine production and fish immunization. Disease surveillance and reporting. Quarantine and health certification in aquaculture. Environmental stress and fish health management in different aquaculture system. SPF and SPR stocks –development and application. Fish pharmacology – different types of aquaculture medicine used in the culture system and their mode of action in fish disease management. Rules and regulation for use of aquaculture medicine.

FSCC502X8: Practical: (Credit-2; Marks- 25)

- Methods of sampling fish and shellfish for disease diagnosis.
- Identification of different finfish fish diseases.
- Identification of different shellfish diseases.
- Taxonomy, lifecycle and identification of fish and shellfish parasites
- Preparation of stained blood film to study various types of WBC.
- Study the different types of medicine used in aquaculture system.
- Application PCR for fish disease diagnosis.
- Study the different molecular and biochemical, histochemical, immunological techniques used for fish disease diagnosis.

Course outcome: Fish pathology and disease management: In this course we give idea to student about different disease problem faced by farmers and possible control measure, different modern aquaculture medicine. Student get job in company and Government to enrich the fish farmers about fish disease. The control of diseases and parasites in aquaculture is essential to meet the requirements of animal welfare and economic production. Parasites are not only

dangerous pathogens in captive fish but also introduced parasites from other continents may pose a serious threat to fish species in wild. Fish disease identification is the most important requirement for fish farmers. Different technique helps to study the fish disease and suggested possible preventive measure to the aquaculturist.

Suggested readings:

1. Bell, T.A. and Lightner, D.V. 1988. A Handbook of Normal Penaeid Shrimp Histology. World Aquaculture Society, Baton Rouge, Louisiana.
2. Brian Austin and Dawn Austin. 2007. Bacterial fish pathogen diseases of Farmed and WildFish: 4th edition. Praxis Publications, Chichester, UK.
3. Edward, J. Noga. 2010. Fish diseases Diagnosis & Treatment: 2nd edition. Wiley Blackwell publications.
4. Ferguson, H. 1989. Systematic Pathology of Fish. Lowa State University Press, Lowa.
5. Gopalakannan, A., A Uma, Felix, S. 2018. Fish Diseases and Management. Daya Publishing House, New Delhi.
6. Jorge C. Eiros, et al. 2008. Fish diseases: Vol.II. Science publishers.
7. Lightner, D.V. 1996. A handbook of Shrimp Pathology and Diagnostic Procedures for Diseases of Cultured Penaeid Shrimp. World Aquaculture Society, Baton Rouge, Louisiana.
8. Roberts, R.J. (Ed.). 1989. Fish Pathology. Bailliere Tindall, New York.
9. Schaperclaus, W. et al, 1991. Fish diseases: Vol. I. Oxonian press pvt. ltd, New Delhi.
10. Shozo Egusa. 1991. Infectious diseases offish. Oxonian press pvt. ltd. New Delhi.
11. Takash Hibiya. 1982. An Atlas of Fish Histology: Normal and Pathological Features. Kodansha Ltd., Tokyo

FSCC503X1: Fish Product Development, Value Addition and Packaging

(Credit- 2; Marks- 25 (5 + 25))

Introduction to fish processing and post-harvest fisheries, nutritional composition of fish, causes of fish spoilage (microbial, enzymatic and oxidative), principles of fish preservation, traditional and modern fish processing methods, and basic equipment used in fish processing. Concept and importance of value addition in fisheries, preparation of fish mince and surimi, development of value-added fish products. Fish processing waste and by-product utilization including production and uses of fish meal, fish oil, fish silage, collagen, gelatin and chitin-chitosan from .Principles and objectives of food packaging, packaging requirements for fresh and processed fish, types of packaging materials (paper, glass, metal and plastics), modern packaging technologies such as vacuum packaging and modified atmosphere packaging, and use of biodegradable and edible packaging materials.

FSCC503X8: Practical (Credit-2; Marks- 25)

- Evaluation of freshness and quality of fish.

- Preparation of fish mince and surimi.
- Preparation of value-added products: Fish cutlet, Fish fingers, Fish pickle, Fish nuggets or fish sausage
- Preparation of ready-to-cook fish products.
- Packaging of fish products using different packaging materials.
- Demonstration of vacuum packaging.
- Determination of shelf life of packaged fish products.
- Identification and testing of packaging materials.
- Visit to a fish processing or packaging unit.
- Sensory evaluation of fish products.

Course Outcomes: After completion of this course, students will be able to: Understand the principles of fish processing and preservation. Develop different value-added fish products for commercial purposes. Utilize fish processing waste for producing economically useful by-products. Apply appropriate packaging technologies to extend shelf life of fish products. Understand packaging standards and regulations for domestic and export markets. Promote entrepreneurship and small-scale fish processing industries.

Suggested readings:

1. Balachandran, K.K. – Post Harvest Technology of Fish and Fish Products.
2. Govindan, T.K. – Textbook of Fish Processing Technology
3. Hall, G.M. – Fish Processing: Sustainability and New Opportunities.
4. FAO – Fish Processing Technology and Quality Assurance.
5. Arun Ninawe, K. Rathnakumar- Fish Processing Technology and Product Development
6. Mishra, R. - Handbook on Fish Processing & Preservation

FSCC504X1: Bio-techniques and Fish Biotechnology (Credit-2; Marks-25 (5 + 25))

Fish cytogenetics and genetic variation: Chromosome structure and organization in fishes, Current techniques in fish cytogenetics, Evolution of fish karyotypes. Genetic improvement in fishes: Hybridization in fishes. Chromosome manipulation techniques: androgenesis, gynogenesis and polyploidy. Reproductive manipulation and sex control: Production of monosex populations and super males. Hormonal manipulation in advancing maturity and reproduction, methods of sex reversal, Biotechnology in fisheries: Transgenesis in fishes, Recombinant DNA technology and proteins of commercial importance. Molecular markers and their applications in aquaculture. Genetic resources and biosafety: Fish genetic resources of India and their conservation. Genetically Modified Organisms (GMOs). Biosafety regulations, ethical issues and Intellectual Property Rights (IPR). Centrifugation, Electrophoresis, Isoelectric focusing, chromatography. Polymerase Chain Reaction (PCR).

FSCC504X8: Practical (Credit-2; Marks- 25)

- Preparation and observation of fish chromosomes (karyotyping) from suitable tissues.
- Study of different stages of cell division (mitosis and meiosis) using prepared slides.
- Study and identification of hybrid fishes and their characteristics.
- Centrifugation, Chromatography.
- Demonstration of protein profiling study by Electrophoresis.
- Demonstration of extraction of DNA from fish tissue.
- Demonstration of agarose gel electrophoresis for DNA separation
- Detection of mutation by Comet Assay.
- Patent and Literature Search
- Short report on Indian biosafety laws, IPR provisions, and international agreements relevant to fisheries.
- Field visit

Course outcome: Upon completion of the course, students will be able to understand chromosome structure, organization, and karyotype evolution in fishes along with current cytogenetic techniques. They will gain knowledge of genetic improvement methods including hybridization, chromosome manipulation (androgenesis, gynogenesis, polyploidy), reproductive manipulation, sex control, production of monosex populations, and hormonal sex reversal. Students will learn applications of biotechnology in fisheries such as transgenesis, recombinant DNA technology, molecular markers, and their use in aquaculture. The course also covers fish genetic resources of India, their conservation, GMOs, biosafety regulations, ethical issues, and IPR. Additionally, students will develop practical skills in centrifugation, electrophoresis, isoelectric focusing, chromatography, and PCR. Overall, the course prepares students for advanced research and applications in fisheries biotechnology.

Suggested Readings:

1. Suzuki, D. T., Griffiths, A. J., Miller, J. H., & Lewontin, R. C. (1986). An introduction to genetic analysis 612pp.Peruzzi, S. (2006). Fish Genetics and Aquaculture Biotechnology: TJ Pandian, CA Strüssmann & MP Marian (eds). Science Publishers, Enfield, USA 2005.
2. Dubey, R. C. (2022). A textbook of Biotechnology. S. Chand Publishing.
3. Dunham, R. (2023). Aquaculture and fisheries biotechnology: genetic approaches. Cabi.
4. R. K. Pandey and S. P. Tripathi (2024) Principles of Fish Genetics NPH, New Delhi
5. Glick, B. R., & Patten, C. L. (2022). Molecular biotechnology: principles and applications of recombinant DNA. John Wiley & Sons.

FSCC505X0: Fisheries Economics and Marketing (Credit-4; Marks- 50 (10+40))

Principles of economics: Definition, basic economic terminologies – micro and macroeconomics, positive and normative economics, Law of diminishing returns, laws of increasing, constant and decreasing utility and returns. Importance of economics in aquaculture development. Economic value of fishes. Maximum Sustainable Yield (MSY), Maximum Economic Yield (MEY), Optimum Sustainable Yield (OSY). Market – equilibrium price, consumption, utility, consumer's surplus. Elasticity – price, income, factors of production, marginal cost and return, law of diminishing marginal return, returns to scale, economies of scale and scope, revenue, profit maximization, Preparation of enterprise budget for integrated fish farming. Socio-Economic analysis, socio demographic profiles of fishermen. Introduction to GATT and WTO. Seafood Export Regulations; Non-Tariff Barriers (NTBs) and Agreement on Anti-Dumping Procedures. Fisheries Trade and Environment; Intellectual Property Rights (IPR) and different forms. Agreement on TRIPS. Bio-piracy. GMOs in fisheries. Overview of Patents in Indian fisheries sector. Functions of fish market – determination of equilibrium price for fish and fisheries products, calculation of price, income and cross elasticities. Economic analysis on cost, return and study the budget for set up production units like fish farm / shrimp farm / seed production unit / fish processing plant / export unit. Preparation of enterprise budget for integrated fish farming. Contribution of fisheries to Indian Agriculture and total GDP. Concept of market, marketing channels, marketing functions, market structure and conduct. Fish market infrastructure. Marketing margins, marketing environment, marketing strategies. Problems of fish marketing in India. Exports and imports of fish and fishery products. Contribution of MPEDA and other associates in exports of fish and fishery products. Marketing system and environment market opportunity identification-customer analysis. Marketing policy and market assessment.

Course outcome: Fisheries extension, economics and marketing: In this course student get idea about transfer the technology to the rural people, economic principle and marketing process of fisheries product. Socioeconomic status development of women. This type of syllabus directly related government job.

Suggested readings:

1. Adivi Reddy, A. 1987. Extension Education. Sree Lakshmi Press, Bapatla, A.P.
2. Bhatia and Bhatia. 1992. A Text Book of Educational Psychology. Boaba House, Delhi.
3. Chaston, I. 1987. Marketing in Fisheries and Aquaculture. Fishing News Books, England.
4. Chitambar, J. B. 1990. Introductory Rural Sociology. Wiley Eastern Ltd., New Delhi.
5. Das, Puspita. 2016. Self Help Groups: Problems Opportunities and Challenges Ahead. Biotech Books.
6. Dewett, K.K. and Varma, J.D. 1993. Elementary Economic Theory. S. Chand, New Delhi.
7. Jayaraman, R. 1996. Fisheries Economics. Tamil Nadu Veterinary and Animal Science University, Tuticorn.
8. Pandey, S.K. 1997.Teaching Communication. Common Wealth Publishers, New Delhi.

9. Rao, N. Subba. 1986. Economics of Fisheries. Daya Publishing House, Delhi.
10. Ravishankar, C.N. 2021. Fishpreneurship Present Status, Challenges and Opportunities. Biotech Books.
11. Saxena, Amita. 2011. Fisheries Extension. Daya Publishing House, New Delhi.
12. Singh, R.K.P. 2003. Economics of Aquaculture. Daya Publishimg House, New Delhi.
13. Supe, S.V. 1997. An Introduction to Extension Education. Second Edition. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

FSCC506X9: Social service /Community Engagement (Credit-2; Marks- 25)

Visit to fishing villages or fish farmer communities to study socio-economic conditions. Conducting participatory rural appraisal (PRA) exercises. Identification of problems faced by fish farmers and fishers. Organizing community awareness programmes on fisheries development. Preparation of extension materials such as leaflets, posters or pamphlets. Interaction with fisheries cooperatives, SHGs or fishermen groups. Conducting training or demonstration programmes for fish farmers. Case study analysis of successful fisheries development programmes. Participation in fisheries social outreach programmes or government schemes.

Course outcomes: After completion of the course, students will be able to: Understand the socio-economic structure of fisheries communities. Apply principles of fisheries extension and community engagement. Plan and implement community-based fisheries development programmes. Communicate fisheries technologies effectively to fish farmers and fishers. Promote participatory approaches and leadership development in fishing communities. Contribute to sustainable fisheries development and social welfare of fishing communities.

Suggested readings:

1. A.W. Van Den Ban & H.S. Hawkins – Agricultural Extension.
2. Saxena, A. – Fisheries Extension.
3. Balvant Singh & Kushwah Mukul Kirar – Rural Sociology and Extension Education.
4. G.L. Ray – Extension Communication and Management.
5. Swanson, Bentz & Sofranko – Improving Agricultural Extension: A Reference Manua*l*.

Semester- IV

FSCC551X0: Fisheries Policies, Laws, International Trade & Intellectual Property Right (IPR) (Credit-4; Marks- 50 (10+40))

Fisheries administrative setup at central and states. Indian Fisheries Act, 1897; The MPEDA Act, 1972; The Maritime Zone of India (regulation of fishing by foreign vessels) Act 1981; Marine Fisheries Policy, 2004; The Coastal Aquaculture Authority Act, 2005; Marine fisheries legislation in the maritime states of India; Code of Conduct for Responsible Fishing; Inland Fisheries Act; Indian wildlife (protection) Act, 1972; The Merchant Shipping Act, 1958; The Coast Guard Act, 1978. FAO's CCCRF; IUU; MCS; UN's Law of the Sea and other conventions; treaties; SAARC, NACA, CBD, CITES, MARPOL, IWC, EU's Common Fisheries Policy, RAMSARSDG-RFMOs; Fisheries policy and regulation of selected countries in Asian American and Australian regions, Eco-labeling and Certification. Overview of intellectual property rights. IPR protection laws and systems. Traditional and indigenous knowledge. Technology incubation and promotion.

Course outcome: Students will develop a comprehensive understanding of fisheries governance, including administrative structures at central and state levels and major national legislations and policies. They will gain knowledge of international conventions, organizations, and global regulatory frameworks related to fisheries, trade, and responsible fishing practices. In addition, students will understand the fundamentals of intellectual property rights, protection systems, and the significance of traditional and indigenous knowledge. They will also gain insight into technology incubation, innovation, and promotion for sustainable fisheries development and management.

Suggested readings:

1. Fisheries Governance and legislation in India. Edited by D.K. Pandey and H.K. De. NPH, New Delhi.
2. Handbook of Fisheries and Aquaculture. ICAR, New Delhi, 2006.
3. Fisheries Development in India. K.K. Vass and M.M. Srivastava, Narendra Publishing House, New Delhi, 2010.
4. Coastal Aquaculture Authority Guidelines and Regulations. Coastal Aquaculture Authority, Chennai.
5. Code of Conduct for Responsible Fisheries. FAO, Rome, 1995.
6. Marine Fisheries Policy Document 2004. Ministry of Fisheries, Animal Husbandry and Dairying, New Delhi.
7. FAO. (2016). Fisheries and Aquaculture Policy and Governance. Rome: FAO.
8. Kurien, J. (2005). Responsible Fish Trade and Food Security. Rome: FAO.
9. World Trade Organization (WTO). (2010). International Trade and Fisheries. Geneva: WTO Publications.
10. WIPO. (2004). Intellectual Property: A Power Tool for Economic Growth. Geneva: World Intellectual Property Organization.

FSCC552X0: Fisheries Extension and Entrepreneurship Development

(Credit-4; Marks- 50 (10+40))

Introduction to extension education and fisheries extension - concepts, objectives and principles; extension education, formal and informal education; History and role of fisheries extension in fisheries development. Fisheries extension methods- individual, group and mass contact methods and their effectiveness, factors influencing their selection and use; characteristics of technology, transfer of technology process; important TOT programs in fisheries; role of NGOs and SHGs in fisheries; Extension program planning and evaluation - steps and importance; participatory planning process. Basic concepts in rural sociology and psychology and their relevance in fisheries extension; social change, social control, social problems and conflicts in fisheries; gender issues in fisheries; theories of learning, learning experience, learning situation. Role of extension in community development. Integrated rural development strategies. Programmes for weaker section of the community. Fishery development plans and various schemes. Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up; managing competition; entrepreneurship development programs; Government schemes and incentives for promotion of entrepreneurship. Fiscal and monitory policies and its impact on entrepreneurship. Infrastructural and other financial requirement for fishery entrepreneurship Government policy on Small and Medium Enterprises (SMEs) / SSIs. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of Indian social, political and economic systems and their decision making by individual entrepreneurs. Globalization and the emerging business /entrepreneurial environment.

Course outcome: The basic objectives of the extension education are the overall development of the rural people. To bring about desirable changes in the human behavior, which includes change in knowledge, skill and attitude? The dissemination of useful and practical information relating to agriculture, including improved seeds, fertilizers, implements, pesticides, improved cultural practices, dairying, poultry nutrition etc. To make the people aware that agriculture is a profit table profession. To create an environment for rural people so that they can show their talent, leadership and efficiency. To provide appropriate solution of the farmer's problems. To bring the scientist closer to the farmers. Small and medium enterprise develop by the farmers. They develop the business mind using the different fisheries tools.

Suggested readings:

1. AbuSaifan, S. 2012. Social Entrepreneurship: Definition and Boundaries. Technology Innovation Management Review,February 2012: 2227. Agricultural innovation systems: An investment sourcebook 2012, The World Bank, Washington, D.C.
2. Andrew, J.G. and Jeffrey, A.R. 2014. Exploring the motivation of nascent social entrepreneurs, Journal of Social Entrepreneurship, 5(1): 521.
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FSCC553X9: Research Project/Dissertation (3 months) (Credit-8; Marks- 100)

- **Dissertation work Report- 60 Marks:** Each student shall have to carry out a dissertation work (laboratory based or field based) under the guidance of a teacher for a period of minimum 3 months. Students shall have to prepare the dissertation report in a standard format and to submit the same in triplicate before the date of examination. (Date will be announced by the department).

- **Evaluation of dissertation work- 40 Marks:** The dissertation work will be evaluated on the basis of the seminar delivered by the student as well as *Viva Voce* on the dissertation work.

Course outcome: The individual dissertation paper is very much required to develop practical knowledge in different aspects of the fishery field that was theoretically studied. This will very much helpful to the students those are implacable future research as well as corporate job. Dissertation work will motivate to engage in research oriented job.

FSCC554X9: Internship (4 weeks) (Credit-4; Marks- 50)

- **Internship Program (Four-Week Practical Training):** Each student will undertake a four-week internship at relevant institutions, industries, farms, or markets, providing practical exposure that supports skill development, employability, and career advancement.

- **Evaluation (100 marks):**

  - Industry/Institute assessment – 30
  - Report writing - 30
  - Presentation of the work - 20
  - *viva voce* -20

Course outcome: Students will gain practical experience and develop skills by applying their knowledge in real situations. They will improve their report writing, communication, and presentation skills, and demonstrate their understanding through viva voce. The internship will also help them learn teamwork, work ethics, and prepare for future jobs.

FSCC555X9: Project/Research proposal writing and Seminar

(Credit-2; Marks- 25)

- This course is designed to develop students' ability to prepare effective project or research proposals and present their ideas clearly through seminars. It emphasizes problem identification, formulation of objectives, research design, methodology, literature review, and scientific writing. Students will also gain experience in organizing and delivering seminars using appropriate presentation tools.

- **Evaluation (25 marks):**

  - Proposal writing (Report/documentation)- 10,
  - Seminar presentation-5,
  - Viva Voce- 10

Course outcome: Students will learn to prepare structured research proposals, develop scientific writing skills, design basic research methodologies, and effectively present their ideas through seminars with clarity and confidence.