Department of Fisheries
Faculty of Fisheries

Curriculum
for
M. S. in Aquaculture
Session: 2020-2021

University of Rajshahi
Rajshahi, Bangladesh

UNIVERSITY OF RAJSHAHI
DEPARTMENT OF FISHERIES
FACULTY OF FISHERIES

Curriculum for M. S. in Aquaculture
Session: 2020-2021

Examinations: Semester-1(January-June) Examination: June, 2026
Semester-2 (July-December) Examination: December, 2026
Semester-3 (January-June) Examination: June, 2027

Part A

1. **Title of the Academic Program: M. S. in Aquaculture**
2. **Name of the University:** University of Rajshahi
3. **Vision of the University:**

To pursue enlightenment and creativity for producing world-class human resources to cater for the needs of changing time.

4. **Mission of the University:**
   - M1. To ensure a world-class curriculum with talented academicians and conducive academic and research environment for generation and dissemination of knowledge.
   - M2. To maintain international standards in education with focus on both knowledge and skills, and humanitarian and ethical values to meet the needs of the society and state.
   - M3. To develop strategic partnerships with leading national and international universities, and organizations for academic as well as research collaborations.
5. **Name of the Program Offering Entity (POE):** Department of Fisheries, Faculty of Fisheries, University of Rajshahi, Bangladesh.
6. **Vision of the Program Offering Entity (POE):**
   Vision of the M. S. in Aquaculture Program

Commitment to academic and research excellence towards sustainable development of aquaculture.

7. **Mission of the Program offering Entity (POE):**
   Mission of the M. S. in Aquaculture Program
   a) To promote aquaculture based advanced academic program.
   b) To develop promising aquaculture technology.
   c) To disseminate aquaculture technologies to the farming community.

8. **Objective of the Program Offering Entity (POE)**

To offer fisheries education to obtain B. Sc. Fisheries (Hons.), Master of Science (MS in Fisheries Biology and Genetics, MS in Aquaculture, MS in Fisheries Management and MS in Fisheries Technology), MPhil and PhD degree in Fisheries; to conduct teaching and research in various fields of Fisheries to increase the fish production and to meet the nutrient requirement.

9. **Name of the Degree:** M. S. in Aquaculture
10. **Description of the Program:**

The Department of Fisheries is established in 2000 under the Faculty of Agriculture in the University of Rajshahi. Later on the department is included under newly formed Faculty of Fisheries in 2020. This department was started with three academic and three non-academic staffs with limited infrastructure facilities by enrolling twenty students. At present, the number of seats for student admission in B. Sc. Fisheries (Honours) level is fifty per year. Now, there are twenty academic staff specialized in different aspects of fisheries sector to enrich education and research in this department. In addition, twenty non-academic staffs are currently working for supporting the department. The department has already demonstrated its outreach excellence through establishing linkages with different donors, associations and industries for research, extension and developmental activities in fisheries sector.

The academic curriculum of the department is being offered in English. The department introduced twelve theoretical and four presentation courses in M. S. in Aquaculture program including culture technology,

nutrition, health management of aquatic animals and aquafarm operation etc.

11. Graduate Attributes (Based on need assessment):

(a) Communicator,
(b) Innovator,
(c) Problem solver,
(d) Leader,
(e) Team builder,
(f) Self- motivated,
(g) Entrepreneur,
(h) Ethically aware,
(i) Digitally skilled,
(j) Multi-tasker and
(k) Adaptable

12. Program Educational Objectives (PEO) of the M. S. in Aquaculture Program

PEO1: To provide post graduate students with a comprehensive insight into aquaculture.
PEO2: To strengthen understanding of the principles and practices of aquaculture.
PEO3: To conduct basic and applied research in different aspects of aquaculture.
PEO4: To disseminate research findings on different aspects of aquaculture.

13. Program Learning Outcomes (PLOs)

At the end of the M. S. in Aquaculture Program, the students will be able to-

PLOs	Program Learning Outcomes (PLOs)
PLO1	Explain the principles required for aquaculture operations as a sustainable basis.
PLO2	Analyze the different aquatic ecosystems to recommend suitable aquaculture techniques
PLO3	Identify different problems to provide solutions in fish farming with respect to different socioeconomic, environmental and geographical contexts.
PLO4	Develop skills in oral and written presentation of results from aquaculture research in popular scientific and academic context

14. Mapping between Mission and PEO

Mission	Program Educational Objectives (PEOs)			
	PEO1	PEO2	PEO3	PEO4
M1	X	X	X	●
M2	X	X	X	●
M3	X	X	X	X

X Strong contribution ● Weak contribution No contribution □

15. Mapping PLOs with the PEOs

PEOs	Program Learning Outcomes (PLOs)			
	PLO1	PLO2	PLO3	PLO4
PEO1	X	X	X	●
PEO2	X	X	X	●
PEO3	●	●	X	X
PEO4	●	●	●	X

X Strong contribution ● Weak contribution No contribution □

16. Mapping courses with PLOs

Course Code	Course Title	PLOs			
		PLO1	PLO2	PLO3	PLO4
0831-521	Advanced Freshwater Aquaculture	X	X	X	●
0831-522	Advanced Fish Pathology	X	●	X	●
0831-523	Advanced Aquaculture Nutrition	X	●	X	●

0831-524	Aquafarm Operation	X	X	X	●
0831-525	Research Methodology in Aquaculture	X	X	X	X
0831-526	Fish Farming Systems	X	X	X	●
0831-527	Mangrove Aquaculture	X	X	X	●
0831-528	Advanced Fish Population Dynamics	●	X	●	●
0831-529	Aquatic Environment and Pollution	X	X	X	●
0831-530	Research Defence-1	X	X	X	X
0831-621	Advanced Coastal Aquaculture and Mariculture	X	X	X	●
0831-622	Advanced Fish Health Management and Pharmacology	X	●	X	●
0831-623	Aquaculture Feed Technology	X	●	X	●
0831-624	Integrated Aquaculture	X	X	X	●
0831-625	Sustainable Aquaculture and Climate Change	X	X	X	●
0831-626	Livelihood in Fisheries	X	X	X	X
0831-627	Aquarium Fish Culture	X	●	X	●
0831-628	Fish Immunology	X	●	X	●
0831-629	Aquaculture Impact	X	X	X	X
0831-630	Research Defence-2	X	X	X	X
0831-721	Thesis	X	X	X	X
0831-722	Thesis Defence	X	X	X	X

X Strong contribution ● Weak contribution □ No contribution

Part B

17. Structure of the curriculum

The M. S. in Aquaculture courses shall consist of compulsory, optional, research defence, thesis and thesis defence. The compulsory courses are of 16 credits, optional courses 8 credits, research defence 4 credits, thesis 8 credits, and thesis defence 4 credits with an aggregate credit of 40 credits. The research work of the thesis should be carried out from the beginning of Semester-1.

M. S. in Aquaculture Semester-1 Examination shall be held at the end of the First Semester having 14 credits, covering six theoretical courses (four compulsory and two optional) including class test and attendance. In addition, a research defence on the problem statement, hypothesis, objectives, expected outcomes, and methodology of the proposed research work will be held at the end of the semester having 2 credits.

M. S. in Aquaculture Semester-2 Examination shall be held at the end of the Second Semester having 14 Credits covering six theoretical courses (four compulsory and two optional) including class test and attendance. In addition, a research defence on findings or progress of proposed research work will be held at the end of the semester having 2 Credits.

M. S. in Aquaculture Semester-3 Examination shall be held at the end of the Third Semester having 12 Credits, covering thesis and thesis defence performances based on research work.

18. Semester wise distribution of courses

DETAILED BREAKS UP OF COURSES

M. S. in Aquaculture Semester-1 (January-June) Examination, June 2026

Course Code	Course Title	Credits
Compulsory		
0831-521	Advanced Freshwater Aquaculture	2
0831-522	Advanced Fish Pathology	2
0831-523	Advanced Aquaculture Nutrition	2
0831-524	Aquafarm Operation	2
Optional (any two)		
0831-525	Research Methodology in Aquaculture	2
0831-526	Fish Farming Systems	2
0831-527	Mangrove Aquaculture	2

0831-528	Advanced Fish Population Dynamics	2
0831-529	Aquatic Environment and Pollution	2
Research work		
0831-530	Research Defence-1	2
	Total	**14**

M. S. in Aquaculture Semester-2(July-December) Examination, December 2026

Course Code	Course Title	Credits
Compulsory		
0831-621	Advanced Coastal Aquaculture and Mariculture	2
0831-622	Advanced Fish Health Management and Pharmacology	2
0831-623	Aquaculture Feed Technology	2
0831-624	Integrated Aquaculture	2
Optional (any two)		
0831-625	Sustainable Aquaculture and Climate Change	2
0831-626	Livelihood in Fisheries	2
0831-627	Aquarium Fish Culture	2
0831-628	Fish Immunology	2
0831-629	Aquaculture Impact	2
Research work		
0831- 630	Research Defence-2	2
	Total	**14**

M. S. in Aquaculture Semester-3 (January-June) Examination, June 2027

Course Code	Course Title	Credits
0831-721	Thesis	8
0831-722	Thesis Defence	4
	Total	**12**
	Grand Total	**40**

Part C

19. Description of the courses

M. S. in Aquaculture Semester-1 (January-June) Examination, June 2026

COMPULSORY COURSES

0831-521: Advanced Freshwater Aquaculture

Credit: 2

Full Marks: 100 [Theory 70, Class Test 20 (written and/or oral) and Attendance 10]

Time: 3 hours (Seven questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete one and half years M.S. in Aquaculture degree. The course deals with different types of culture types such as monoculture, polyculture, integrated aquaculture and low-cost aquaculture. The course is designed to estimate and suggest feed requirement, and feeding strategy in different aquaculture systems. Additionally, it focuses on solutions and suggestions to the problems of on- going freshwater aquaculture operations.

Learning Outcomes:

At the end of the course, the students will be able to: i) demonstrate different freshwater aquaculture practices; ii) provide solutions and suggestions to the problems of on- going freshwater aquaculture operations; iii) manage hatchery practices.

At the end of the course, the students will be able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe the present culture practices all over the country.	2
CLO2	Demonstrate and suggest about monoculture, polyculture, integrated aquaculture, low-cost aquaculture	3
CLO3	Estimate and suggest feed requirement and feeding strategy in different aquaculture systems.	3
CLO4	Manage freshwater aquaculture farm.	3
CLO5	Demonstrate and suggest about culture of commercially available fish species.	3
CLO6	Demonstrate and suggest culture of commercially available fish and shellfishes.	4
CLO7	Operate artificial breeding program in hatchery.	3

Mapping CLOs with PLOs

CLOs	PLOs			
	PLO1	PLO2	PLO3	PLO4
CLO1	X	X	X	●
CLO2	X	X	X	●
CLO3	X	X	X	●
CLO4	X	X	X	●
CLO5	X	X	X	●
CLO6	X	X	X	●
CLO7	X	X	X	●

X Strong contribution ● Weak contribution □ No contribution

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Present status of culture practices, importance, their problem, solutions and future prospects of aquaculture in Bangladesh.	Lectures followed by discussion Participatory question-answer	Full Marks: 100 (Theory: 70, Class Test: 20 & Attendance:

CLO2	Culture techniques, their advancement, problems and solutions of monoculture, polyculture, integrated aquaculture, low-cost aquaculture and sustainable aquaculture in Bangladesh.	Lectures followed by discussion Participatory question-answer	10)
CLO3	Feed and nutritional requirement in different types of culture system and culture species, feed ingredients, feed formulation, and feed regime	Lectures followed by discussion Participatory question-answer	
CLO4	Management practices for freshwater aquaculture (pre-stocking, stocking, and post-stocking management.	Lectures followed by discussion Participatory question-answer	
CLO5	Culture of carps, catfishes, tilapias, thaipunti, pangas.	Lectures followed by discussion Participatory question-answer	
CLO6	Culture of shrimp, prawns, cuchia and crabs.	Lectures followed by discussion Participatory question-answer	
CLO7	Hatchery management: Induced breeding techniques, inbreeding problem in aquaculture and techniques of broodstock management.	Lectures followed by discussion Participatory question-answer	

Recommended books/literature:

1. Integrated fish Farming System Holds Promise in Bangladesh, A. K. M. Nuruzzaman (1991), Two Sisters.
2. Water Quality Management in Aquaculture, M. S. Rahman (1992), BRAC Prokashana.
3. A Manual of Freshwater Aquaculture, R. Santhanam, N. Sukumaran and P. Natarajan (1987), Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, Bombay, Calcutta.
4. Fish and Fisheries of India. V. G. Jhingran (1988). Hindustan Publ. Corp. Delhi.
5. Text Book of Fish Culture Breeding and Cultivation of Fish, Marcel Huet (1972), Fishing News Books Ltd., Farnham, Surrey, England.
6. Fisheries Resources and Opportunities in Freshwater Fish Culture in Bangladesh, M. Ameen, (1987), PAT, NRD-II/Danida, Noakhali, Bangladesh.
7. Warm Water Fish Pond, Boyd.
1. Aquaculture Management by James W. Meade (1998). CBS Publishers, India.

0831-522: Advanced Fish Pathology

Credit: 2

Full Marks: 100 [Theory 70, Class Test (Written and/or Oral) 20 and Attendance 10]

Time: 3 hours (Seven questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete one and half years M.S. in Aquaculture degree. The course covers the understanding of fish pathogen and pathogenic disease problems in cultured fish. The course designed to develop knowledge of fish pathogen, interactions between fish and pathogen, and course of disease development in fish. This course can also teach defense mechanism pathogenic organisms. This course will also be focused on types of common disease problems, their symptoms and pathology, epizootiology and distribution in culture environment.

Learning Outcomes:

At the end of the course, the students will be able to- i) distinguish fish pathogens and signs development ii) recognize causes that lead to the development of fish disease iii) learn necropsy techniques and procedures and perform post-mortem examinations.

At the end of the course, the students will able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Define fish pathology, pathogen, stress and disease; know the types of pathogen and importance of pathology in aquaculture, explain the factors responsible for stress and disease, understand the relation between stress and disease; know the pathological changes of diseased fish.	3
CLO2	Understand the types, system involvement and mechanism of non-specific and specific defence of fish.	3
CLO3	Define pathogenicity, virulence and pathogenesis; understand the factors and mechanism of microbial pathogenicity and pathogenesis.	3
CLO4	Define histopathology; learn the slide preparation technique for histopathological study, observed the histopathological changes in different organs of diseased fish.	3
CLO5	Understand the infectious disease (fungal, bacterial and viral) in fish and shrimp.	4
CLO6	Understand the environmental, nutritional, hereditary disease in fish and shrimp.	3
CLO7	Know the concept, necessity, symptoms and assessing of immunopathology, understand the mechanism of autoimmunity and immunodeficiency.	3

Mapping CLOs with PLOs

CLOs	PLOs			
	PLO1	PLO2	PLO3	PLO4
CLO1	X	X	X	●
CLO2	X	X	X	●
CLO3	X	X	X	●
CLO4	X	X	X	●
CLO5	X	X	X	●
CLO6	X	X	X	●
CLO7	X	X	X	●

X Strong contribution ● Weak contribution □ No contribution

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Introduction: Concept of pathology, importance of disease to aquaculture, factors responsible for the disease, role of stress to produce disease, fish pathogens, infection, pathological changes, epizootiology.	Lectures followed by discussion Online resources	Full Marks: 100 (Theory: 70, Class Test: 20 & Attendance: 10)
CLO2	Defence mechanisms of fish: Non-specific immunity – physical barriers, chemical, humoral and cellular factors); specific immunity–antibody-mediated immunity (structure, type, and function of immunoglobins, mechanisms of immunoglobulin formation); cell-mediated immunity and immune memory.	Lectures followed by discussion Online resources Slide show	
CLO3	Pathogenicity: Concept and mechanism of fungal, bacterial and viral pathogenicity.	Lectures followed by discussion Online resources	
CLO4	Infectious diseases: Common parasitic, fungal, bacterial, viral diseases in fish and shrimp with their etiology, symptoms, pathology, diagnosis, epizootiology, and distribution.	Lectures followed by discussion Online resources	
CLO5	Non-infectious diseases: Common environmental, dietary and hereditary diseases in fish and shrimp.	Lectures followed by discussion Online resources	

CLO6	Histopathology:Definition and importance of histopathology, slide preparation technique for histopathological study, histopathological changes in different organs of diseased fish.	Lectures followed by discussion Online resources Slide show	
CLO7	Immunopathology: Concept, necessity, symptoms and assessing of immunopathology, autoimmunity and, immunodeficiency.	Lectures followed by discussion Online resources	

Recommended books/literature:

1. Fish Pathology (2nd edn.). R. J. Roberts (editor) (1989). Bailliers and Tindall, London.
2. Fish Diseases vol. 1 and 2. W. Schaperclaus (1991). Oxanion Press Pvt. Ltd. New Delhi, Calcutta.
3. Bacterial Pathogens; Diseases in Farmed and Wild Fish. B. Austin and D. A. Austin (1987). Ellis Horwood Ltd.
4. Text Book of Fish Diseases. E. Amlacher (1970). TFH Publication.
5. Bacterial and Viral Diseases of Fish. J. H. Cross (editor) (1983). Washington Sea Grant Publication.
6. Diseases of Fishes (1971). S. Sarig (Edited by- Dr. Stanislaus, F. Snieszko and Dr. Herbert R. Axelrod). T. F. H. Publications Inc. Ltd.
7. Identification of Fish Pathogenic Bacteria. G. L. Bullock (1980). TFH Publication.
8. Fish Defenses Vol. 1: Immunology. Editors: G. Zaccone, J. Meseguer, A. Garcia-Ayala and B.G. Kapoor (2017). CRC press.
9. Fish Immunology (1st Edition). Editors: M. J. Manning and M. F. Tatner (1985). Academic press.

0831-523: Advanced Aquaculture Nutrition

Credit: 2

Full Marks: 100 [Theory 70, Class Test (Written and/or Oral) 20 and Attendance 10]

Time: 3 hours (Seven questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete one and half years M.S. in Aquaculture degree. The course describes dietary protein and amino acid requirement of culturablefish and shell fish. The course coverslarval and brood stock nutritional requirement and formulate feed for brood and larval fish. Further, it focuses on digestion of feed and factors affecting digestibility for maximum utilization of feed. The course is designed to provide a broad knowledge about nutritional disorder in fish.

Learning Outcomes:

At the end of the course, the students will be able to know i) about the fish nutrition concerning the nutrient-carbohydrate, protein, lipid and also vitamin and mineral requirement of fish, crustacean and mollusk etc. and; ii) the energy metabolism, brood stock nutrition, nutritional disorders, digestion, digestibility, larval nutrition and growth of fish, crustacean and mollusk etc.

At the end of the course, the students will able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe Nutritional terminology and role of nutrition in fisheries and aquaculture;	1
CLO2	Demonstrate and formulate nutritional value of protein, optimum dietary protein level, Dietary Protein and amino acid requirement of fish and shell fish.	3
CLO3	Describe and demonstrate application of sources of nutrition: naturally produced food in ponds; food produced through fertilization and supplementary feeding and complete artificial feeding.	3
CLO4	Compare digestion of feed: General anatomy and organ physiology, definition of digestion, digestive fluids and enzymes secreted in teleost fish. Protein, fat, carbohydrate and microbial digestion.	3
CLO5	Analyze digestibility in fish, determination of digestibility, Markers, Factors influencing digestibility.	3
CLO6	Discuss the Energy metabolism in cultivated fishes and crustaceans: units of measurement and definition of terms, partitioning of biological energy, energy flow in animal system, specific dynamic action (SDA), energy metabolism in fish, energy	3

	requirement of fish, factors effecting energy requirement of fish, dietary energy sources.	
CLO7	Studies on larval nutrient requirement, protein, lipid and vitamins requirements. Larval feed development for aquaculture.	2
CLO8	Explain Broodstock nutrition: energy partitioning for reproduction, protein requirement of broodstock, effect of dietary quality on reproductive output, known nutritional requirements of some broodstock fishes. Formulate feed for broodstock.	2
CLO9	Describe nutritional disorders in protein lipid and mineral deficiency.	

Mapping CLOs with PLOs

CLOs	PLOs			
	PLO1	PLO2	PLO3	PLO4
CLO1	X	X	X	●
CLO2	X	X	X	●
CLO3	X	X	X	●
CLO4	X	X	X	●
CLO5	X	X	X	●
CLO6	X	X	X	●
CLO7	X	X	X	●
CLO8	X	X	X	●
CLO9	X	X	X	●

X Strong contribution ● Weak contribution □ No contribution

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Introduction, rationale and expected outcome.	Lectures followed by discussion Participatory question-answer	Full Marks: 100 (Theory: 70, Class Test: 20 & Attendance: 10)
CLO2	Definition of fish nutrition; nutritional requirements of culturable fishes and shellfishes; proteins and amino acids; lipids and fatty acids; carbohydrates, vitamins, minerals, and water.	Lectures followed by discussion Participatory question-answer Online resources	
CLO3	Sources of nutrition: Naturally produced food; food produced through fertilization and supplementary feeding and complete artificial feeding.	Lectures followed by discussion Participatory question-answer Online resources	
CLO4	Digestion and absorption of feed: General anatomy and organ physiology, digestive fluids and enzymes, protein, fat, carbohydrate and microbial digestion, rate of digestion andaffecting factors; absorption.	Lectures followed by discussion Participatory question-answer Online resources	
CLO5	Digestibility of fish feed: Digestion co-efficient, determination of nutrient digestibility, apparent and true digestibility, factors affecting digestibility.	Lectures followed by discussion Participatory question-answer Online resources	
CLO6	Energy metabolism in cultivated fishes and crustaceans:Units of measurement and definition of terms, partitioning of biological energy, energy flow in the animal system, specific dynamic action, energy metabolism and requirement of fish, factors affecting energy requirement of fish, dietary energy sources.	Lectures followed by discussion Participatory question-answer Online resources	

CLO7	Larval nutrition: nutritional requirements of some larval fishes. Protein, lipid and vitamins requirements. Larval feed development.	Lectures followed by discussion Participatory question-answer	
CLO8	Broodstock nutrition:Energy partitioning for reproduction, protein requirement of broodstock, the effect of dietary quality on reproductive output, known nutritional requirements of broodstock fish.	Lectures followed by discussion Participatory question-answer	
CLO9	Nutritional disorders:Disorders in protein nutrition, disorders in lipid nutrition, disorders in mineral deficiency, disorders in vitamin nutrition	Lectures followed by discussion Participatory question-answer	

Recommended books/literature:

1. Fish Nutrition (2nd ed.). J. E. Halver (1989). Academic Press Inc. New York.
2. Nutrition of Pond Fishes. B. Hepher (1988). Cambridge University Press.
3. Principles of Fish Nutrition. W. Steffers (1989). Ellis Horwood Ltd. John Wiley and Sons. New York.
4. Finfish Nutrition and Fish Feed Technology. vol. I and II. J. E. Halver and K. Tiews (editors) (1979). NeenemannGmbh and Co. Berlin.

0831-524: Aquafarm Operation

Credit: 2

Full Marks: 100 [Theory 70, Class Test (Written and/or Oral) 20 and Attendance 10]

Time: 3 hours (Seven questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete one and half years M.S. in Aquaculture degree. The course describes different techniques for designing, construction and management of different types of aquafarms and hatcheries. The course focuses on the management of land-based aquafarm and hatchery waste management, aeration-oxygenation and feed delivery system. This will also help the students to design and estimate costing of different types of aquafarms and hatcheries.

Expected Outcomes:

At the end of the course, the students will be able to- i) select suitable site for establishing different types of aquafarms and hatcheries ii) design and estimate different types of aquafarms and hatcheries iii) design and manage water and oxygen supply, and waste management of aquafarm.

At the end of the course, the students will be able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Recognize the present practices, problems and importance of aquafarm operation in Bangladesh.	1
CLO2	Can select the site of culture areas, design and construction of culture facilities in shore areas; various farming techniques (intertidal, sub-tidal, pens, floating cages, etc.); breeding and larval rearing of marine fin fishes, prawns and other marine organisms.	3
CLO3	Design and modify fish and shrimp hatcheries along with different components.	2
CLO4	Design and modify different types of ponds, tanks and raceway pens.	3
CLO5	Design different types of water-based aquaculture system-rafts, longlines, table and tubes, cages.	3
CLO6	Apply and design different pumps and aeration devices for refill and oxygenate the ponds and tanks.	3
CLO7	Design and construct filtration and disinfection devices in different aquafarms and hatcheries.	2
CLO8	Manage aquafarm and hatchery waste; and feed delivery system.	2
CLO9	Estimate and evaluate investment and return in different aquafarm and hatchery	2

	operations.	

Mapping CLOs with PLOs

CLOs	PLOs			
	PLO1	PLO2	PLO3	PLO4
CLO1	X	X	X	●
CLO2	X	X	X	●
CLO3	X	X	X	●
CLO4	X	X	X	●
CLO5	X	X	X	●
CLO6	X	X	X	●
CLO7	X	X	X	●
CLO8	X	X	X	●
CLO9	X	X	X	●

X Strong contribution ● Weak contribution □ No contribution

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Present practices, problems and importance of aquafarm operation in Bangladesh.	- Lectures followed by discussion - Participatory question-answer	**Full Marks: 100** (Theory: 70, Class Test: 20 & Attendance: 10)
CLO2	Criteria for site selection of different types of aquafarms and hatcheries.	- Lectures followed by discussion - Participatory question-answer	
CLO3	Aquafarm and hatchery layout (finfish, shrimp and prawn) with different components including infrastructure. Problems in existing aquafarms and hatcheries and their possible improvements.	- Lectures followed by discussion - Participatory question-answer	
CLO4	Aquaculture' systems: ponds, tanks, and raceways pens, recirculating and flow through systems.	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO5	Mariculture systems: rafts, longlines, table and tubes, sea cages.	- Lectures followed by discussion - Participatory question-answer	
CLO6	Aeration-oxygen transfer processes, different kinds of aerators used in different aquaculture systems.	- Lectures followed by discussion - Participatory question-answer	
CLO7	Water supply and water quality management, sedimentation. filtration and disinfection in different aquafarms and hatcheries.	- Lectures followed by discussion - Participatory question-answer	
CLO8	Aquafarm and hatchery waste management, Feed delivery systems in aquaculture.	- Lectures followed by discussion - Participatory question-answer	
CLO9	Investment appraisal of aquafarm operation, Return on investment, internal rate of return, Cost-benefit analysis.	- Lectures followed by discussion - Participatory question-answer	

Recommended books/literature:

1. Designs and Construction of Earth Dams. K. D. Nelson (1985). Inkata Press, Melbourne.
2. Aquaculture Engineering. F. W. Roberts (1987). Robert E. Krieger Publ., Florida.
3. Elementary Guide to Fish Culture in Nepal. E. Woynarovitch (1975). FAO, Rome.
4. Thomas B. Lawson (1995).Fundamentals of Aquaculture Engineering. Springer US.
5. Jenner, Andrew (2010)."Recirculating aquaculture systems: The future of fish farming". Christian Science Monitor. Retrieved August 25, 2015.

6. Robert Stickney (1994). Principles of Aquaculture (2nd ed.). Wiley. p. 91
7. Simple Methods for Aquaculture Management for Freshwater Practices. FAO Training Series 21/1. 1997. Baba BarkaNath Printers, New Delhi, India.

OPTIONAL COURSES

0831-525: Research Methodology in Aquaculture

Credit: 2

Full Marks: 100 [Theory 70, Class Test (Written and/or Oral) 20 and Attendance 10]

Time: 3 hours (Seven questions to be set and five to be answered)

Course Description:

This course is an optional theoretical course for understanding the research, problems in research, research design, samplings, selection of appropriate statistical test, writing scientific papers, thesis and project and application of computer in research. The course is designed to strengthen the student's existing knowledge of research and its and application to aquaculture-based research with appropriate data analyses and statistical test. Additionally, this course covers basic understanding on writing scientific paper/ Thesis/ Project proposal.

Learning Outcomes:

At the end of the course, the students will be able to: i) understand some basic concepts of research and its methodologies; ii) select and define appropriate research problem and parameters; iii) prepare a project proposal; iv) organize and conduct research in a more appropriate manner; v) write a research report and thesis.

At the end of the course, the students will be able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe rationale, importance and expected outcomes of learning research methodology in aquaculture.	1
CLO2	Outline aquaculture research and terminologies.	2
CLO3	Describe and design aquaculture research.	2
CLO4	Describe, suggest and perform fieldworks for research purpose.	2
CLO5	Explain and perform lab works.	2
CLO6	Describe, write and present research proposal / synopsis.	2
CLO7	Describe and write thesis paper.	2
CLO8	Describe and write scientific article.	3
CLO9	Describe and write project proposal and final report.	2
CLO10	Describe and write reference for journal papers, books, proceedings, conference paper, electronic documents, unpublished documents, etc.	2
CLO11	Describe and write assignment.	2

Mapping CLOs with PLOs

CLOs	PLOs			
	PLO1	PLO2	PLO3	PLO4
CLO1	X	X	X	X
CLO2	X	X	X	X
CLO3	X	X	X	X
CLO4	X	X	X	X
CLO5	X	X	X	X
CLO6	X	X	X	X
CLO7	X	X	X	X
CLO8	X	X	X	X
CLO9	X	X	X	X
CLO10	X	X	X	X
CLO11	X	X	X	X

X Strong contribution ● Weak contribution □ No contribution

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Rationale, importance and expected outcomes of learning research methodology in aquaculture.	- Lectures followed by discussion - Participatory question-answer	Full Marks: 100 (Theory: 70, Class Test: 20 & Attendance: 10)
CLO2	An introduction to research methodology: Aquaculture research and terminologies, Research advisor, Problems on research, Importance and Scope of studying of research methodology.	- Lectures followed by discussion - Participatory question-answer	
CLO3	Research design: Principle, field layout, Sampling design, Measurement and Scaling technique, Methods of Data collection etc.	- Lectures followed by discussion - Participatory question-answer	
CLO4	Fieldworks: Access to the field, Site visit, Data/Sample collection, Data records and Sample preservation etc.	- Lectures followed by discussion - Participatory question-answer	
CLO5	Lab works: Sample maintenance, Marking/Tagging, Dissecting, Different measurements etc.	- Lectures followed by discussion - Participatory question-answer	
CLO6	Research proposal writing/Synopsis writhing: Research background including importance, problem statement and objective, Methodology including a time frame, Expected findings, citation.	- Lectures followed by discussion - Participatory question-answer	
CLO7	Thesis writing: Abstract, introduction, methodology, review of literature, results, discussion, Recommendation and citation	- Lectures followed by discussion - Participatory question-answer	
CLO8	Scientific article writing: Abstract, introduction, methodology, results and discussion, Recommendation and citation.	- Lectures followed by discussion - Participatory question-answer	
CLO9	Project proposal writing, Project progress report and final report writing.	- Lectures followed by discussion - Participatory question-answer	
CLO10	Reference writing: journal papers, books, proceedings, conference paper, electronic documents, unpublished documents, etc.	- Lectures followed by discussion - Participatory question-answer	
CLO11	Assignment: Presentation on thesis title, introduction including importance and objects and methodology.	- Lectures followed by discussion - Participatory question-answer	

Recommended books/literature:

1. Kothari CR (2004) Research Methodology - Methods and Techniques (2nd Edition). New Age International Publishers.
2. Kumar R (2010) Research Methodology: A Step-by-Step Guide for Beginners (Third Edition). SAGE Publications Ltd.
3. Bhattacherjee A (2012) Social science research: principles, methods and practices. University of South Florida. Florida.
4. Burrows T (2011) Writing research articles for publication. Thailand: The Asian
5. Burton S and Steane P (eds) (2004) Surviving your thesis. London: Routledge
6. Dawson C (2002) Practical research methods: a user-friendly guide to mastering research techniques and projects. Oxford: How To Books Ltd.
7. Given LM (ed) (2008) The Sage encyclopedia of qualitative research methods, volumes 1 & 2. California, Thousand Oaks: Sage Publications.
8. De Leeuw ED, Hox JJ and Dillman DA (eds) (2008) International handbook of survey methodology. EAM.
9. Walliman N (2011) Research methods: the basics. Oxon: Routledge.

10. SeltmanHj (2014) Experimental design and analysis. Carnegie Mellon University.
11. Neergaard H and Ulhoi JP (eds) (2007) Handbook of qualitative research methods in entrepreneurship. UK. Edward Elgar Publishing Ltd.
12. Modern Language Association of America (2009) MLA handbook for writers of research papers. 7th ed. New York: Modern Language Association of America.
13. Statistics for Aquaculture

0831-526: Fish Farming Systems

Credit: 2

Full Marks: 100 [Theory 70, Class Test (Written and/or Oral) 20 and Attendance 10]
Time: 3 hours (Seven questions to be set and five to be answered)

Course Description:

This course is an optional theoretical course to complete one and half years M.S. in Aquaculture degree. The course includes determinants and components of farming system; and integration between components. The course comprises problem and prospects of entrepreneurship in aquaculture. This course will help students to be spirited as an entrepreneur in aquaculture sector.

Learning Outcomes:

At the end of the course, the students will be able to- i) distinguish fish farming system and farming system research ii) describe different tools of farming system research and apply in aquaculture research field.iii) explain limitations of aquaculture boost-up in Bangladesh iv) spirited to be an entrepreneur in aquaculture sector.

At the end of the course, the students will able to-

CLOs	Course LearningOutcomes	Lectures
CLO1	Describe about rationale and outcome of learning fish farming system.	1
CLO2	Define fish farming systems, farming system research and farming system development. Describe the characteristics, aim, importance and classification of farming system.	3
CLO3	Describe determinants and components of farming system and integration between components.	3
CLO4	Explain development and limitations of development in Bangladesh.	3
CLO5	Describe different tools of farming system research and apply in aquaculture research field.	3
CLO6	Differentiate between entrepreneur and promotor, describe the character, quality and barrier of an entrepreneur.	3
CLO7	Know the limit of loan, and terms and conditions for granting loan for different culture system of different bank and NGO's; and will be prepare as an entrepreneur.	3
CLO8	Know the trend of aquaculture development in Bangladesh and formulate future plan to fulfill the need of increased population.	3

Mapping CLOs with PLOs

CLOs	PLOs			
	PLO1	PLO2	PLO3	PLO4
CLO1	X	X	X	●
CLO2	X	X	X	●
CLO3	X	X	X	●
CLO4	X	X	X	●
CLO5	X	X	X	●
CLO6	X	X	X	●
CLO7	X	X	X	●
CLO8	X	X	X	●

X Strong contribution ● Weak contribution □ No contribution

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Rationale, importance and expected outcomes of learning fish farming system and farming system research in Bangladesh.	- Lectures followed by discussion - Participatory question-answer	**Full Marks: 100** (Theory: 70, Class Test: 20 & Attendance: 10)
CLO2	Fish farming systems, farming system research and farming system development: characteristics, aim, importance and classification	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO3	Determinants and components of farming system and integration between components.	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO4	Development and limitations of aquaculture in Bangladesh.	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO5	Tools of farming system research and their application in aquaculture research field.	- Lectures followed by discussion - Participatory question-answer	
CLO6	Entrepreneur: characteristics, risk, quality and barrier. Entrepreneurship in aquaculture.	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO7	Bank loan in aquaculture sector: the limit of loan, terms and conditions for granting loan for different culture system of different bank and NGO's.	- Lectures followed by discussion - Participatory question-answer -Online resources	
CLO8	Trend of aquaculture development in Bangladesh, Future plan to fulfill the need of increased population	- Lectures followed by discussion - Participatory question-answer	

Recommended books/literature:

1. Integrated fish Farming System Holds Promise in Bangladesh, A. K. M. Nuruzzaman (1991), Two Sisters.
2. Water Quality Management in Aquaculture, M. S. Rahman (1992), BRAC Prokashana
3. A Manual of Freshwater Aquaculture, R. Santhanam, N. Sukumaran and P. Natarajan (1987), Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, Bombay, Calcutta.
4. Fish and Fisheries of India. V. G. Jhingran (1988). Hindustan Publ. Corp. Delhi.
5. Text Book of Fish Culture Breeding and Cultivation of Fish, Marcel Huet (1972), Fishing News Books Ltd., Farnham, Surrey, England.

0831-527: Mangrove Aquaculture

Credit: 2

Full Marks: 100 [Theory 70, Class Test (Written and/or Oral) 20 and Attendance 10]

Time: 3 hours (Seven questions to be set and five to be answered)

Course Description:

This course is an optional theoretical course to complete one and half years M.S. in Aquaculture degree. The course covers the flora and faunal community of mangrove, their proper utilization and management. The course describes theimportance of mangrove plant as nursery ground of important cultivable fish species.This course will help the students to manage conservation of mangrove dependent fisheries in Sundarbans areas.

Learning Outcomes:

At the end of the course, the students will be able to i) describe flora and fauna of mangrove; ii) suggest utilization of mangrove areas for aqua farm; iii) integrate mangrove aquaculture with agriculture, Livestock, and wildlife.

At the end of the course, the students will able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe about rationale and outcome of learning mangrove aquaculture.	1
CLO2	Describe flora and fauna resources of Mangrove.	3
CLO3	Practice and manage aquafarm in mangrove areas.	3
CLO4	Utilize mangrove areas for aqua farms.	2
CLO5	Manage conservation of mangrove dependent fisheries in Sundarbans areas.	2
CLO6	Manage sustainable exploitation of the mangroves for aquaculture in Bangladesh.	2
CLO7	Describe the importance of mangrove plant as nursery ground of cultivable species of fisheries.	2
CLO8	Outline factors affecting the recruitment of fish and shellfish in mangrove areas.	2
CLO9	Manage and suggest aquaculture operation in acid sulphate soil.	2
CLO10	Manage and integrate mangrove aquaculture with agriculture, Livestock, and wildlife.	2

Mapping CLOs with PLOs

CLOs	PLOs			
	PLO1		PLO3	PLO4
CLO1	X	X	X	●
CLO2	X	X	X	●
CLO3	X	X	X	●
CLO4	X	X	X	●
CLO5	X	X	X	●
CLO6	X	X	X	●
CLO7	X	X	X	●
CLO8	X	X	X	●
CLO9	X	X	X	●
CLO10	X	X	X	●

X Strong contribution ● Weak contribution □ No contribution

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Rationale, importance and expected outcomes of learning mangrove aquaculture.	-Lectures followed by discussion -Participatory question-answer	**Full Marks: 100** (Theory: 70, Class Test: 20 & Attendance: 10)
CLO2	**Mangrove resources:** importance, present status and prospects of mangrove aquaculture in Bangladesh.	-Lectures followed by discussion -Participatory question-answer	
CLO3	Aquafarm practices and management in mangrove areas.	-Lectures followed by discussion -Participatory question-answer	
CLO4	Utilization of mangrove areas for aqua farms.	-Lectures followed by discussion -Participatory question-answer	
CLO5	Mangrove dependent fisheries in Sundarbans areas with reference to cultivable species.	-Lectures followed by discussion -Participatory question-answer	
CLO6	Sustainable exploitation of the mangroves for aquaculture in Bangladesh.	-Lectures followed by discussion -Participatory question-answer	
CLO7	Role of mangrove plant as nursery ground of important cultivable species of fisheries.	-Lectures followed by discussion -Participatory question-answer	
CLO8	Factors affecting the recruitment of fish and shellfish in mangrove areas.	-Lectures followed by discussion -Participatory question-answer	
CLO9	Management of acid sulphate soil for an aquaculture operation.	-Lectures followed by discussion -Participatory question-answer	
CLO10	Integration of mangrove aquaculture with agriculture, Livestock, and wildlife.	-Lectures followed by discussion -Participatory question-answer	

Recommended books/literature:

1. Aquaculture, J. E. Bardach, J. H. Ryther and W. O. Mclarney (1972), John Wiley and Sons. Inc., New York.
2. Coastal Aquaculture in the Indo-Pacific Region, T. V. R. Pillay (1973), Fishing News (Books) Ltd., London.
3. Aquaculture in Shallow seas: Progress in Shallow Sea Culture, T. Imai (1977), Oxford IBH Publ. Co., New Delhi, Bombay, Calcutta.
4. Prawn and Prawn Fisheries of India, C. V. Kurian and V. O. Sebastian (1976), Hindustan Publ., New Delhi.
5. Crustacean Farming, D. C. C. Lee and J. F. Wichins (1991), Oxford Fishing News Books/ Blackwell Sci. Publ. Ltd.
6. CRC Hand Book of Mariculture, Vol. 1: Crustacean Aquaculture, J. McVey, J. Moore (1983).
1. 7.Recent Advances in Aquaculture, Vol. 1, J. F. Muir and R. J. Roberts (eds) (1982), Croom Helm, London.

0831-528: Advanced Fish Population Dynamics

Credit: 2

Full Marks: 100 [Theory 70, Class Test (Written and/or Oral) 20 and Attendance 10]

Time: 3 hours (Seven questions to be set and five to be answered)

Course Description:

This course is an optional theoretical course to complete one and half years M.S. in Aquaculture degree. The course covers the understanding of population parameters, size relationship and condition factors. This course is designed to provide a broad knowledge on the distribution and abundance, growth pattern, reproduction, recruitment, migration and mortality of fish. This course can also teach the relationship length-length and length weight relationship and condition factors, and production of fish. This course will also be focused on the terms, MSY, MYE, marking and tagging and prey-predator relationship in aquatic environment.

Learning Outcomes:

At the end of the course, the students will be able to: i) know about the distribution and abundance, growth pattern, reproduction, recruitment, migration and mortality of fish; ii) explain the relationship length-length and length weight relationship and condition factors of fishes.

At the end of the course, the students will be able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Define the population of fish and its scope and application in fisheries science and also to know its related terminologies.	2
CLO2	Estimate the Distribution and abundance and to know its affecting factors.	2
CLO3	Describe fish stock; learn methods to separate different fish stock.	2
CLO4	Know the timing of recruitment, length & age at recruitment, factors affecting recruitment and stock-recruitment relationships.	3
CLO5	Know the definition & types of migration, causes of migration, migratory circuit of fishes, migration of some important commercially important fishes (Hilsha, hering, cod etc.).	2
CLO6	Estimate the mortality through length-based models by age-based & length-based catch curves, Beverton& Holt equations, and Weatherall plots and affecting factors on it.	2
CLO7	Describe the types, materials and duration of tags and marks, principles and techniques of tagging and marking and its application of fisheries research.	2
CLO8	Estimate the growth parameters through different models (e.g., von Bertalanffy growth curve) using data from length-frequency analysis, hard part analysis, mark-recapture experiment, and graphical & computer-based analyses	3
CLO9	Know the Linear regression, length-length and length-weight relationships, and condition factors of fish populations and also to know the gear selectivity by covered codend& alternate haul experiments and gill net selectivity.	3

Mapping CLOs with PLOs

CLOs	PLOs			
	PLO1	PLO2	PLO3	PLO4
CLO1	X	X	X	●
CLO2	X	X	X	●

CLO3	X	X	X	●
CLO4	X	X	X	●
CLO5	X	X	X	●
CLO6	X	X	X	●
CLO7	X	X	X	●
CLO8	X	X	X	●
CLO9	X	X	X	●

X Strong contribution ● Weak contribution □ No contribution

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Definition, importance, and basis of fish population dynamics study; terminology related to fish population dynamics study, characteristics of the population	- Lectures followed by discussion - Participatory question-answer	**Full Marks: 100** (Theory: 70, Class Test: 20 & Attendance: 10)
CLO2	**Distribution and abundance:** Distribution types, factors affecting distributions, relative abundance, absolute abundance of fish populations and their estimations	- Lectures followed by discussion - Participatory question-answer	
CLO3	**Stock:** Definition, characteristics of fish stock, the importance of studying fish stock, methods for separating different fish stocks.	- Lectures followed by discussion **- Participatory question-answer**	
CLO4	**Recruitment:** Definition, timing of recruitment, length & age at recruitment, factors affecting recruitment and stock-recruitment relationships	- Lectures followed by discussion **- Participatory question-answer**	
CLO5	**Migration:** Definition, Causes of migration, types of migration, migratory circuit of fishes, migration of some important commercially important fishes (Hilsha, herring, cod etc.).	- Lectures followed by discussion **- Participatory question-answer**	
CLO6	**Mortality:** Factors causing mortality, concept of mortality equation; estimation of fishing mortality by age-based & length-based catch curves, Beverton& Holt equations, and Weatherall plots; natural mortality and its estimation.	- Lectures followed by discussion **- Participatory question-answer**	
CLO7	**Marking and tagging:** Definition, types, materials and duration of tags and marks, principles and techniques of tagging and marking.	- Lectures followed by discussion **- Participatory question-answer**	
CLO8	**Growth of fish:** Definition and types, acquaintance with different growth models; Procedures for estimating the parameters of the von Bertalanffy growth curve using data from length-frequency analysis, hard part analysis, mark-recapture experiment, and graphical and computer-based analyses.	- Lectures followed by discussion **- Participatory question-answer**	
CLO9	**Size relationships and gear selectivity:** Linear regression, length-length and length-weight relationships and condition of fish populations; gear selectivity by covered codend and alternate haul	- Lectures followed by discussion **- Participatory question-answer**	

	experiments, gill net selectivity.		

Recommended books/literature:

1. Cushing, D.H., 1968. Fisheries Biology: A study in population dynamics. Univ. Wisconsin, Madison, USA.
2. Cushing, D.H., 1977. Science and the Fisheries. Edward Arnold Publishers Ltd. 25, Hill Street, London WIX 8LL.
3. Dwiponggo, A., 1986. Growth, mortality and recruitment of commercially important fishes and penaeid shrimps in Indonesian waters. Filipiniana Specialist, Manila.
4. FAO. 2001. Yearbook of fishery. Statistics of catches and landings.
5. Gulland, J.A. (ed.), 1983. Fish Stock Assessment: A Manual of Basic Methods. Chichester, U.K., Wiley Interscience, FAO/Wiley series on food and agriculture, Vol. 1.
6. Gulland, J.A. (Ed.), 1988. Fish Population Dynamics. Second edition. John Wiley & Sons, Inc., New York.
7. King, M., 1995. Fisheries Biology, Assessment and Management. Fishing News Books.

0831-529: Aquatic Environment and Pollution

Credit: 2

Full Marks: 100 [Theory 70, Class Test (Written and/or Oral) 20 and Attendance 10]

Time: 3 hours (Seven questions to be set and five to be answered)

Course Description:

This course is an optional theoretical course to complete one and half years M.S. in Aquaculture degree. The course covers the understanding of potentialities of different aquatic environments and the degradation pathways of aquatic environment. The course designed to develop knowledge of aquatic environmental principles, regulatory/limiting factors and environmental alteration. This course can also teach the mechanisms of aquatic environmental pollution from different sources. This course will also be focused on aquatic environmental legislations authority and amelioration process of aquatic environmental pollution.

Learning Outcomes:

At the end of the course, the students will understand major source, type and causes of aquatic pollution and will be able to control pollution in aquaculture farm management.

At the end of the course, the students will be able to:

CLOs	Course Learning Outcomes	Lecture
CLO1	Describe about rationale and expected outcome of the course.	1
CLO2	Explain and demonstrate about potentials and importance of aquatic environment in fish farming.	1
CLO3	Explain about the principles of aquaculture ecosystem.	2
CLO4	Learn about physical factors of aquatic environment like light, temperature, pressure and depth of aquatic environment; and how these factors can affect fish production in pond fish farming; and apply this knowledge in pond management.	2
CLO5	Learn about chemical factors of aquatic environment like pH, DO, CO_2, alkalinity, hardness and ammonia-nitrogen; and how these factors can affect fish production in pond fish farming; and apply this knowledge in pond management.	2
CLO6	Learn about biological factors of aquatic environment like plankton community, stocking density, stocking ratio and predation and how these factors can affect fish production in pond fish farming; and apply these knowledge in pond management.	2
CLO7	Learn about different aquaculture related activities and how these activities can affect our environment and apply this knowledge in mitigating environmental problems due to such activities.	2
CLO8	Explain about the source and causes of aquatic pollution; and apply these learning in preventing pollution in fish pond.	2
CLO9	Define water pollution and water scarcity;categorize and explain the causes of water pollution and water scarcity and their impacts.	2
CLO10	Describe the causes of industrial pollution, explain present status of industrial pollution in Bangladesh, know the impact of such kind of pollution on fisheries resources; and apply these learning in preventing industrial pollution in aquatic environment.	2

CLO11	Describe the source and causes of agrochemical pollution, explain the impact of such kind of pollution on fisheries resources; and apply these learning in preventing agrochemical pollution in aquatic environment.	2
CLO12	Define algal bloom and algal toxin, describe the types and impact of harmful algal bloom in fish pond; and apply these learning for better production by controlling algal bloom.	2

Mapping CLOs with PLOs

CLOs	PLOs			
	PLO1	PLO2	PLO3	PLO4
CLO1	X	X	X	●
CLO2	X	X	X	●
CLO3	X	X	X	●
CLO4	X	X	X	●
CLO5	X	X	X	●
CLO6	X	X	X	●
CLO7	X	X	X	●
CLO8	X	X	X	●
CLO9	X	X	X	●
CLO10	X	X	X	●
CLO11	X	X	X	●
CLO12	X	X	X	●

X Strong contribution ● Weak contribution □ No contribution

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Present status, importance and expected outcomes	- Lectures followed by discussion - Participatory question-answer	Full Marks: 100 (Theory: 70, Class Test: 20 & Attendance: 10)
CLO2	Introduction: Concept, types, and potentials of the aquatic environment, the importance of aquatic environment maintenance	- Lectures followed by discussion - Participatory question-answer	
CLO3	Environmental principles: Principles and their application to the management of the aquatic ecosystem	- Lectures followed by discussion - Participatory question-answer	
CLO4	Physical factors of aquatic environment (light, temperature, pressure and depth): importance, effect, fluctuations and control measures.	- Lectures followed by discussion - Participatory question-answer	
CLO5	Chemical factors of aquatic environment (DO, CO_2, alkalinity, hardness, pH, ammonia, nitrogen-nitrite etc.): importance, effect, fluctuations and control measures.	- Lectures followed by discussion - Participatory question-answer	
CLO6	Biological factors of aquatic environment (phytoplankton, stocking density, grazing etc.): importance, effect, fluctuations and control measures.	- Lectures followed by discussion - Participatory question-answer	
CLO7	Impacts of aquaculture on the aquatic environment, mitigation measures.	-Lectures followed by discussion - Participatory question-answer	
CLO8	Environmental degradation: Definition, causes, and impacts of environmental degradation on fisheries.	- Lectures followed by discussion - Participatory question-answer	

CLO9	Water pollution and water scarcity: Categories and causes of water pollution and water scarcity, state and impact of water pollution and scarcity, human response, gaps and future concerns, actions for pollution management.	- Lectures followed by discussion - Participatory question-answer	
CLO10	Industrial pollution: Causes and present state of industrial pollution in Bangladesh, impacts on fisheries resources and control.	- Lectures followed by discussion - Participatory question-answer	
CLO11	Agrochemicals pollution: Agrochemicals concern water pollution, ways of pollution and impacts.	- Lectures followed by discussion - Participatory question-answer	
CLO12	Algal pollution:Definition, cause and types of harmful algal bloom, algal toxins, impacts of algal pollution on fisheries.	- Lectures followed by discussion - Participatory question-answer	

Recommended books/literature:

1. Lloyd, R. 1992. Pollution and Freshwater Fish. Fishing News Books, Oxford, 176.
2. Moriarty, F. 1993. Ecotoxicology: The Study of Pollutants in Ecosystems. Second Edition. T. J. Press (Padstow) Ltd., Padstow, Cornwall, Great Britain. 289 pp.
3. Boyd, C. E. 1988. Water Quality Management for Pond Fish Culture. Elsevier Scientific Publisher B. V., Amsterdam. 318 pp.
4. Calhoun, Y. 2005. Water Pollution. Chelsea House Publishers. 164 pp.
5. Calow, P. 1993 (ed.) Handbook of Ecotoxicology. Volume One. T.J. Press (Padstow) Ltd., Padstow, Cornwall, Great Britain. 289 pp.
6. Carmichael, W. W. 1981 (ed.). The Water Environment: Algal Toxins and Health. Plenum Press. New York. 491 pp.
7. Falconer, I. R. 1993. Algal Toxins in Sea Food and Drinking Water. Academic Press. 224 pp.

Research Work

0831-530: Research Defence-1

Credit: 2

Full Marks: 100

Expected Outcomes:

At the end of the research defence, intensive and constructive discussions of proposed research projects from definition of problem statement, hypothesis and research objectives through different scientific approaches, research design and expected data analysis will enable student to develop critical thinking and scholarly skills in developing research proposal

At the beginning of Semester-1, all students will be attached to the academic staff as a supervisor. Students/They will face a research defence based on the problem statement, hypothesis, objective, expected outputs and limitations, review of literature and methodology of the proposed research.

M. S. in Aquaculture Semester-2 (July-December) Examination, December 2026

COMPULSORY COURSES

0831-621: Advanced Coastal Aquaculture and Mariculture

Credit: 2

Full Marks: 100 [Theory 70, Class Test (Written and/or Oral) 20 and Attendance 10]

Time: 3 hours (Seven questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete one and half years M.S. in Aquaculture degree. The course covers the understanding of present status and future prospect of coastal aquaculture and aquaculture systems in coastal region. This course is designed to provide a broad knowledge on aquaculture practices for fin fish and shell fish species in coastal and marine area. This course can also teach on estimation of the resources available to develop coastal aquaculture practices for the culture of finfish, shellfish and seaweeds. This course will also be focused on mangrove fisheries, and pearl biology and culture.

Learning Outcomes:

At the end of the course, the students will be able to: i) manage coastal aquaculture and mariculture system; ii) develop coastal aquaculture and mariculturefor culture of brackish water finfish, shellfish and seaweeds.

At the end of the course, the students will be able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Discuss about coast, coastal and marine areas, coastal boundaries, present status and problems of coastal aquaculture and mariculture in Bangladesh.	2
CLO2	Identify the coastal aquaculture practices in open, semi closed, closed, polder culture and new approaches.	3
CLO3	Select the site of culture areas, design and construction of culture facilities in shore areas; various farming techniques (intertidal, sub-tidal, pens, floating cages, etc.); breeding and larval rearing of marine fin fishes, prawns and other marine organisms.	3
CLO4	Learn and practice different culture techniques of marine fishes (mullet, seabass, milk fish etc.), shrimps and prawns, crabs, mussels, clams, oysters, scallop, squid, green turtle and sea-weeds.	4
CLO5	Discuss about mangrove ecosystem; energy flow in mangrove swamp; impact of deforestation; prospects of fisheries and fish culture in mangrove areas.	3
CLO6	Know about various pearl bearing oysters, life cycle of pearl oyster and techniques of pearl culture	4
CLO7	Different systems of Cage culture and rope culture.	2

Mapping CLOs with PLOs

CLOs	PLOs			
	PLO1	PLO2	PLO3	PLO4
CLO1	X	X	X	●
CLO2	X	X	X	●
CLO3	X	X	X	●
CLO4	X	X	X	●
CLO5	X	X	X	●
CLO6	X	X	X	●
CLO7	X	X	X	●

X Strong contribution ● Weak contribution □ No contribution

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Introduction: Present status, problems and prospects of coastal aquaculture and	- Lectures followed by discussion - Participatory question-answer	Full Marks: 100 (Theory: 70,

	mariculture in Bangladesh.		Class Test: 20 & Attendance: 10)
CLO2	Coastal aquaculture practices: Open, semi closed, closed, polder culture and new approaches.	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO3	Site selection, design and construction of culture facilities in shore areas; various farming techniques (intertidal, sub-tidal, pens, floating cages, etc.); breeding and larval rearing of marine fin fishes, prawns and other marine organisms.	- Lectures followed by discussion - Participatory question-answer	
CLO4	Culture techniques of marine fishes (mullet, sea bass, milk fish etc.), shrimps and prawns, crabs, mussels, clams, oysters, abalone, scallop, squid, green turtle and sea-weeds.	- Lectures followed by discussion - Participatory question-answer	
CLO5	Mangrove fisheries: Mangrove ecosystem; energy flow in mangrove swamp; impact of deforestation; prospects of fisheries and fish culture in mangrove areas.	- Lectures followed by discussion - videos - Online resources	
CLO6	Pearl culture: Life cycle of pearl oyster, techniques of pearl culture	- Lectures followed by discussion with Power Point presentation and videos	
CLO7	Mariculture techniques: Cage culture, rope culture etc.	- Lectures followed by discussion with PowerPoint presentation	

Recommended books/literature:

1. Aquaculture, J. E. Bardach, J. H. Ryther and W. O. Mclarney (1972), John Wiley and Sons. Inc., New York.
2. Coastal Aquaculture in the Indo-Pacific Region, T. V. R. Pillay (1973), Fishing News (Books) Ltd., London.
3. Aquaculture in Shallow seas: Progress in Shallow Sea Culture, T. Imai (1977), Oxford IBH Publ. Co., New Delhi, Bombay, Calcutta.
4. Farming at the Edge of the Sea, E. S. Iverson (1968), Fishing News Books Ltd., London.
5. Prawn and Prawn Fisheries of India, C. V. Kurian and V. O. Sebastian (1976), Hindustan Publ. Co., New Delhi.
6. Crustacean Farming, D. C. C. Lee and J. F. Wichins (1991), Oxford Fishing News Books/ Blackwell Sci. Publ. Ltd.
7. CRC Hand Book of Mariculture, Vol. 1: Crustacean Aquaculture, J. McVey, J. Moore (1983).
8. CRC Hand Book of Mariculture, Vol. II: Finfish Aquaculture, J. McVey (1991).

0831-622: Advanced Fish Health Management and Pharmacology

Credit: 2

Full Marks: 100 [Theory 70, Class Test (Written and/or Oral) 20 and Attendance 10]

Time: 3 hours (Seven questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete one and half years M.S. in Aquaculture degree. The course covers the understanding of major health problems of fish and its management strategies. This course is designed to provide a broad knowledge on fish health problems and its diagnosis, and to develop management strategies to maintain the disease-free status for cultured stocks. This course can also teach prophylaxis and treatment measures against pathogenic and non-pathogenic diseases problems. This course will also be focused on common medicines types, sources, uses and mode of actions against pathogen.

Learning Outcomes:

At the end of the course, the students will be able to- i) recognize causes that lead to degrade the fish health ii) learn necropsy techniques and procedures and perform post-mortem examinations and iii) learn minimizing techniques of fish health hazards.

At the end of the course, the students will able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Define health and health management; know the objectives and the basics of fish health management.	1
CLO2	Understand the sanitation practices for fish ponds and tanks, recirculation systems; water, diets, animals, hands, feet and equipment, new species, eggs, design facility.	2
CLO3	Know the effective principles of prophylaxis of fish disease.	2
CLO4	Describe the importance of history and records; understand the submission techniques of water and fish sample to the diagnostic laboratory.	2
CLO5	Know the principles and techniques of disease diagnosis.	3
CLO6	Describe the types of therapy and the therapeutic treatments.	2
CLO7	Know the methods of vaccination, factors determine how well a vaccine will work, the requirement for developing a vaccine.	3
CLO8	Explain the prevention and control ways of common infections and noninfectious fish diseases.	3
CLO9	Know the effects of intensification on shrimp health; understand the relationship between health and environment; describe the health hazards and their management.	3

Mapping CLOs with PLOs

CLOs	PLOs			
	PLO1	PLO2	PLO3	PLO4
CLO1	X	X	X	●
CLO2	X	X	X	●
CLO3	X	X	X	●
CLO4	X	X	X	●
CLO5	X	X	X	●
CLO6	X	X	X	●
CLO7	X	X	X	●
CLO8	X	X	X	●
CLO9	X	X	X	●

X Strong contribution ● Weak contribution □ No contribution

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	**Introduction of fish health management:** Definition and objectives of fish health management; the basic concept of fish health management.	- **Lectures followed by discussion** - Online resources	**Full Marks: 100** (Theory: 70, Class Test: 20 & Attendance: 10)
CLO2	**Sanitation practices for aquaculture facilities:** Sanitation practices for fish ponds and tanks, recirculation systems; water, diets, animals, hands, feet and equipment, new species, eggs, design facility.	- **Lectures followed by discussion** - Online resources - Slide show	
CLO3	**Prophylaxis of fish disease:** Effective principles of prophylaxis of fish disease.	- **Lectures followed by discussion** - **Online resources**	
CLO4	**Submission of fish for diagnostic evaluation:** Importance of history and records, submission techniques of water and fish sample to the diagnostic laboratory, the value of the sample.	- **Lectures followed by discussion** - Online resources - Slid show	

CLO5	**Diagnosis of fish disease:** Principles of disease diagnosis, epidemiological and clinical diagnosis, postmortem examination, microbiological, histopathological and haematological methods.	- **Lectures followed by discussion** - Online resources - Slide show	
CLO6	**Therapy of fish disease:** Definition and types of therapy, chemotherapy, chemotheraputic treatment.	- **Lectures followed by discussion** - Online resources - Slide show	
CLO7	**Vaccination in aquaculture:** Definition and methods of vaccination, vaccines for fish, factors determine how well a vaccine will work, the requirement for developing a vaccine, vaccines and disease control.	- **Lectures followed by discussion** - Online resources	
CLO8	**Prevention and control of diseases:** Common infections and noninfectious diseases in fish.	- **Lectures followed by discussion** - Online resources	
CLO9	**Shrimp health maintenance:** Effects of intensification on shrimp health, the relationship between health and environment; health hazards and their management.	- **Lectures followed by discussion** - Online resources - **Slide show**	

Recommended books/literature:

1. Introduction to Fish Health Management. Vinyl Bound (1995) by Becky A. Lasee (Editor)
2. Introduction to Fish Health Management (1995) by Becky A. Lasee, LaCrosse, Fish Health Center (US).
3. Fish Diseases vol. 1 and 2. W. Schaperclaus (1991). Oxanion Press Pvt. Ltd. New Delhi.
4. Bacterial Pathogens; Diseases in Farmed and Wild Fish. B. Austin and D. A. Austin (1987). Ellis Horwood Ltd.
5. Bacterial and Viral Diseases of Fish. J. H. Cross (editor) (1983). Washington Sea Grant Publication.
6. Diseases of Fishes (1971). S. Sarig (Edited by- Dr. Stanislaus, F. Snieszko and Dr. Herbert R. Axelrod). T. F. H. Publications Inc. Ltd.

0831-623: Aquaculture Feed Technology

Credit: 2

Full Marks: 100 [Theory 70, Class Test (Written and/or Oral) 20 and Attendance 10]

Time: 3 hours (Seven questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete one and half years M.S. in Aquaculture degree. The course covers the understanding of fish feed concerning feed ingredients sources, live feed, feed formulation, processing, feed industry and feed storage. This course focuses on proximate composition of dietary ingredients and naturally occurring toxins feedstuff.This course will also demonstratedifferent techniques and methodologies for fish feeding at field level.

Learning Outcomes:

At the end of the course, the students will be able to i) formulate fish feed with ingredients of different sources; ii) manage feed processing industry; iii) provide suggestions for feed storage.

At the end of the course, the students will be able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe present scenario of feed use in aquaculture in Bangladesh and the importance of feed in intensive and semi-intensive aquaculture.	1
CLO2	Describe conventional and unconventional feedstuff, dietary ingredients, proximate	4

	composition of dietary ingredients and naturally occurring toxins feedstuff.	
CLO3	Outline non-nutrient dietary components such as water, hormone, antibiotics, fibers, binders, antioxidants, pigments, and feeding stimulants.	3
CLO4	Formulate and suggest microencapsulated diet for larval rearing.	4
CLO5	Formulate, prepare fish feed and provide suggestions for feed processing and storage.	3
CLO6	Apply different Feeding methods such as Broadcasting, feeder, demand and non-demand feeders, feed particles shape and size.	4
CLO7	Learn and apply techniques and methodologies for fish feeding experiments: control environmental studies and field studies.	2

Mapping CLOs with PLOs

CLOs	PLOs			
	PLO1	PLO2	PLO3	PLO4
CLO1	X	X	X	●
CLO2	X	X	X	●
CLO3	X	X	X	●
CLO4	X	X	X	●
CLO5	X	X	X	●
CLO6	X	X	X	●
CLO7	X	X	X	X

X Strong contribution ● Weak contribution □ No contribution

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Introduction, rationale, and outcomes.	- Lectures followed by discussion - Participatory question-answer	Full Marks: 100 (Theory: 70, Class Test: 20 & Attendance: 10)
CLO2	Feedstuff: Conventional and unconventional feedstuff, dietary ingredients available in Bangladesh. Proximate composition of dietary ingredients and fertilizers. Naturally occurring and adventitious toxins feedstuff.	- Lectures followed by discussion - Participatory question-answer	
CLO3	Non-nutrient dietary components, water, hormone, antibiotics, fibers, binders, antioxidants, pigments, and feeding stimulants.	- Lectures followed by discussion - Participatory question-answer	
CLO4	Microencapsulated diet for larval rearing, live feed.	- Lectures followed by discussion - Participatory question-answer	
CLO5	Food formulation, Preparation and processing — supplementary and complete diets: feed formulation and preparation for cultivable species, feed milling processes, the effect of processing on the nutritional value of feed, quality control in feed manufacture, manufacture of compounded feeds in developing countries. Feed storage.	- Lectures followed by discussion - Participatory question-answer	
CLO6	Feeding methods for supplementary and complete diets: Selection of feel ingredients feed preparation supplemental feeding and natural productivity, feeding level and frequency. Economics of supplemental	- Lectures followed by discussion - Participatory question-answer	

	and complete feeding.		
CLO7	Techniques and methodologies for fish feeding experiments: Control environmental studies and field studies.	- Lectures followed by discussion - Participatory question-answer	

Recommended books/literature:

1. Tropical Feeds, tropical Feeds. B. Gohl (1981). Food and Agricultural Organization,UN, Rome.
2. Finfish Nutrition and Fish Feed Technology. vol. I-II. J. E. Halver and K. Tiews (editors) (1979). H. Heenmann GmbH and Co. Berlin.
3. Fish Feed Technology. Aquaculture Development and Coordination Programme 1980. UNDP/FAO, Rome.
4. Fish Feeds and Feeding in Developing Countries. Aquaculture Development and Coordination Programme (1983). ACDP/REP/83/18 UNDP/FAO, Rome.
5. A Guide to Tilapia Feeds and Feeding. K. Jauncey and D. Ross (1982). Institute of Aquaculture, University of Stirling, Scotland.
6. Toxic Constituents of Plant Foodstuffs. D. E. Linear (editor). Academic Press, New York.
7. Feed and Feeding of Fish and Shrimp. M. B. New (1987). ACDP/REP/87/26 UNDP/FAO, Rome.

0831-624: Integrated Aquaculture

Credit: 2

Full Marks: 100 [Theory 70, Class Test (Written and/or Oral) 20 and Attendance 10]

Time: 3 hours (Seven questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete one and half years M.S. in Aquaculture degree. The course is designed to strengthen the student's existing knowledge on scope, potentiality, problem, culture and management of integrated aquaculture like fish cum livestock and paddy cum fish culture. Additionally, this course covers basic understanding of aquaponics and bio-floc based fish farming. The course also focuses on economic evaluation and resource assessment of integrated aquaculture.

Learning Outcomes:

At the end of the course, the students will be familiar with different integrated aquaculture practices; manage integrated aquaculture farm and provide solutions to the problems of on- going integrated aquaculture operations.

At the end of the course, the students will able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe the rationale, present status, outcome and prospects of integrated aquaculture in Bangladesh	2
CLO2	Know the practices, problems and solutions of integrated farming of fish and livestock, such as duck cum fish; poultry cum fish; cattle cum fish farming; and apply this learning in small- or large-scale farm management.	4
CLO3	Learn the practices, problems and solutions of integrated farming of paddy and fish; and apply this learning in small- or large-scale farm management.	4
CLO4	Recognize the practices, problems and solutions of biofloc based fish farming; and apply this learning in farm management.	2
CLO5	Know the practices, problems and solutions of aquaponic based fish farming; and apply this learning in farm management.	2
CLO6	Recognize the practices, problems and solutions of using biogas slurry in fish farming; and apply this learning in farm management.	2
CLO7	Manage waste fed pond.	2
CLO8	Evaluate economic and resource assessment of integrated aquaculture.	2

Mapping CLOs with PLOs

CLOs	PLOs			
	PLO1	PLO2	PLO3	PLO4

CLO1	X	X	X	●
CLO2	X	X	X	●
CLO3	X	X	X	●
CLO4	X	X	X	●
CLO5	X	X	X	●
CLO6	X	X	X	●
CLO7	X	X	X	●
CLO8	X	X	X	●

X Strong contribution ● Weak contribution □ No contribution

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Present status, importance and expected outcomes of integrated aquaculture in Bangladesh.	- Lectures followed by discussion - Participatory question-answer	**Full Marks: 100** (Theory: 70, Class Test: 20 & Attendance: 10)
CLO2	Principles, types, management practices, problems and control measures of integrated farming of fish and livestock, such as duck cum fish; poultry cum fish; cattle cum fish farming.	- Lectures followed by discussion - Participatory question-answer	
CLO3	Principles, types, management practices, problems and control measures of integrated farming of paddy and fish.	- Lectures followed by discussion - Participatory question-answer	
CLO4	Principles, types, management practices, problems and control measures of biofloc based fish farming.	- followed by discussion - Participatory question-answer	
CLO5	Principles, types, management practices, problems and control measures of aquaponic based fish farming.	- Lectures followed by discussion - Participatory question-answer	
CLO6	Principles, types, management practices, problems and control measures of using biogas slurry in fish farming.	- Lectures followed by discussion - Participatory question-answer	
CLO7	Management of waste fed ponds: Addition of wastes: stocking and harvesting procedure: and maintaining environmental conditions	- Lectures followed by discussion - Participatory question-answer	
CLO8	Economic and resource assessment: The effect of the value of resource on integration: The economics of using waste in aquaculture; Integrated use of' land and water in aquaculture: social consideration and energy budgeting and nutrient transfer.	- Lectures followed by discussion - Participatory question-answer	

Recommended books/literature:

1. Integrated fish Farming System Holds Promise in Bangladesh, A. K. M. Nuruzzaman (1991), Two Sisters.
2. Water Quality Management in Aquaculture, M. S. Rahman (1992), BRAC Prokashana.
3. A Manual of Freshwater Aquaculture, R. Santhanam, N. Sukumaran and P. Natarajan (1987), Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, Bombay, Calcutta.
4. Fish and Fisheries of India. V. G. Jhingran (1988). Hindustan Publ. Corp. Delhi.
5. Text Book of Fish Culture Breeding and Cultivation of Fish, Marcel Huet (1972), Fishing News Books Ltd., Farnham, Surrey, England.

OPTIONAL COURSES

0831-625: Sustainable Aquaculture and Climate Change

Credit: 2

Full Marks: 100 [Theory 70, Class Test (Written and/or Oral) 20 and Attendance 10]

Time: 3 hours (Seven questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite for understanding the courses related to climate change and its historical and future trends, global warming, causes of climate change, greenhouse effects, human effects on climate. The course is designed to strengthen the student's existing knowledge on the vulnerability to climate change and adaptation with excessive rainfalls and floods, storms, hurricanes, and tropical cyclones, sea level rise, salinity intrusion and land subsidence. This course is also designed for understanding the potential positive and negative impacts, vulnerability of regions, adaptation and mitigation measures in fisheries and aquaculture, sustainable development, sustainable aquaculture and sustainable aquaculture framework.

Learning Outcomes:

At the end of the course, the students will be able to i) understand climate change, concept of sustainable development and sustainable aquaculture; ii) explain impact, adaptation and mitigation measures of climate change in fisheries and aquaculture.

At the end of the course, the students will able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe the rationale, and need of sustainable aquaculture in Bangladesh.	1
CLO2	Describe history, and concept of sustainable development and sustainable aquaculture.	1
CLO3	Outline sustainable aquaculture framework.	2
CLO4	Explain resource use in sustainable aquaculture.	2
CLO5	Describe the science of climate change.	2
CLO6	Co-relate aquaculture production and climate change.	2
CLO7	Explain impacts of climate change on aquaculture.	2
CLO8	Describe climate change impacts on tropical and temperate fisheries, aquaculture, and seafood security and implications.	2
CLO9	Describe potential impacts of aquaculture on climate change.	2
CLO10	Describe adaptation and mitigation measures in fisheries and aquaculture.	1
CLO11	Describe impacts of climate change on fisheries in Bangladesh.	2
CLO12	Describe climate change variability in Rajshahi district.	2

Mapping CLOs with PLOs

CLOs	PLOs			
	PLO1	PLO2	PLO3	PLO4
CLO1	X	X	X	●
CLO2	X	X	X	●
CLO3	X	X	X	●
CLO4	X	X	X	●
CLO5	X	X	X	●
CLO6	X	X	X	●
CLO7	X	X	X	●
CLO8	X	X	X	●
CLO9	X	X	X	●
CLO10	X	X	X	●
CLO11	X	X	X	●
CLO12	X	X	X	●

X Strong contribution ● Weak contribution □ No contribution

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Introduction, rationale and outcomes	- Lectures followed by discussion	**Full Marks: 100** (Theory: 70, Class Test: 20 & Attendance: 10)
CLO2	Definition, history and concept of sustainable development and sustainable aquaculture.	- Lectures followed by discussion - Participatory question-answer	
CLO3	Sustainable aquaculture framework: Production technologies, social and economic aspects and environmental aspects and their interrelationships.		
CLO4	Resources use in sustainable aquaculture: Systems ecology and comparable food systems, land and water use, energy use, feed and seed sources; the trend of resource allocation in aquaculture and sustainable development.	- Lectures followed by discussion - Participatory question-answer	
CLO5	Climate change: Weather, climate, climate variability and climate change; Causes of climate change: Natural processes affecting the earth's temperature, Greenhouse gases.	- Lectures followed by discussion - Participatory question-answer	
CLO6	Aquaculture production and climate change: The significance of fisheries and aquaculture, Climatic distribution of production, Environmental-climatic distribution of aquaculture, Climatic-national-regional distribution of aquaculture, Growth trends in aquaculture, Aquaculture and GDP.	- Lectures followed by discussion - Participatory question-answer	
CLO7	Impacts of climate change on aquaculture: Major climatic changes that would potentially impact on aquaculture, Facets of aquaculture vulnerability to climate changes, Direct and Indirect impacts of climate change on aquaculture, Social impacts of climate change on aquaculture.	- Lectures followed by discussion - Participatory question-answer	
CLO8	Climate change impacts on tropical and temperate fisheries, aquaculture, and seafood security and implications: Rise in temperatures, Ocean acidification, Sea-level rise, Extreme events.	- Lectures followed by discussion - Participatory question-answer	
CLO9	Potential impacts of aquaculture on climate change: Comparison of carbon emissions/contributions to greenhouse gases from animal husbandry and aquaculture, carbon sequestration, Estimating aquaculture's potential contribution to climatic change.	- Lectures followed by discussion - Participatory question-answer	
CLO10	Adaptation and mitigation measures in fisheries and aquaculture	- Lectures followed by discussion - Participatory question-answer	
CLO11	Impacts of climate change on fisheries in Bangladesh: Effects on reproduction and growth of fish, Effects on species composition, abundance and distribution, Effects on aquaculture, effects on habitat	- Lectures followed by discussion - Participatory question-answer	

	quality and migration Routes, Impact of climate change on the biology of major carp.		
CLO12	Climate change variability in Rajshahi district: Increase in air and water temperature, Decrease annual rainfall and increases annual Evaporation, Fish farmers' perceptions on climate variability.	- Lectures followed by discussion - Participatory question-answer	

Recommended books/literature:

1. Climate change implications for fisheries and aquaculture. (2009), fisheries and aquaculture technical paper-530.
2. Challenging the Aquaculture Industry on Sustainability: Technical overview (2008). Michelle Allsopp, Paul Johnston & David Santillo. Greenpeace Research Laboratories Technical Note 01/2008.
3. FAO **(**2015). Assessing climate change vulnerability in fisheries and aquaculture: Available methodologies and their relevance for the sector, by Cecile Brugère and Cassandra De Young. FAO Fisheries and Aquaculture Technical Paper No. 597. Rome, Italy.
4. Desilva, Sena and Soto, D 2009, Climate change and aquaculture: potential impacts, adaptation and mitigation, Fao Fisheries and Aquaculture Technical Paper, vol. 530.

0831-626: Livelihood in Fisheries

Credit: 2

Full Marks: 100 [Theory 70, Class Test (Written and/or Oral) 20 and Attendance 10]

Time: 3 hours (Seven questions to be set and five to be answered)

Course Description:

This course is an optional theoretical course for understanding livelihood of fisheries community, their problems, security and vulnerability. The course emphasizes case study, and floodplain, coastal fisheries and char fisheries in livelihood development.

Course Objectives:

To provide the knowledge of the livelihood in Fisheries, concept, framework, security and vulnerability, case study, and floodplain, coastal fisheries and char fisheries in livelihood development.

Learning Outcomes:

At the end of the course, the students will be able to know about the livelihood concept, framework, security and vulnerability, case study, and floodplain, coastal fisheries and char fisheries in livelihood development.

At the end of the course, the students will be able to:

CLOs	Course Learning Outcomes	Lectures
CLO1	Explain the introductory aspects, rationale, and expected outcome.	1
CLO2	Describe the concept of livelihood.	1
CLO3	Explain the SLA framework.	2
CLO4	Describe about livelihood security and vulnerability.	2
CLO5	Describe the livelihood analysis, case study.	2
CLO6	Explain about the livelihood assets of the fishermen households.	4
CLO7	Describe about the char fisheries livelihood.	2
CLO8	Describe about the floodplain and coastal fisheries in livelihood development.	4
CLO9	Explain the sustainable livelihood approaches and government perspective.	2
CLO10	Explain about livelihood strategies, process, and outcomes.	1

Mapping CLOs with PLOs

CLOs	PLOs			
	PLO1	PLO2	PLO3	PLO4
CLO1	X	X	X	●
CLO2	X	X	X	●
CLO3	X	X	X	●
CLO4	X	X	X	●
CLO5	X	X	X	●
CLO6	X	X	X	●
CLO7	X	X	X	●
CLO8	X	X	X	●
CLO9	X	X	X	●
CLO10	X	X	X	●

X Strong contribution ● Weak contribution □ No contribution

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Introduction, rationale, and expected outcome.	- Lectures followed by discussion - Participatory question-answer	**Full Marks: 100** (Theory: 70, Class Test: 20 & Attendance: 10)
CLO2	Concept of livelihood.	- Lectures followed by discussion - Participatory question-answer	
CLO3	SLA framework.	- Lectures followed by discussion - Participatory question-answer	
CLO4	Livelihood security and vulnerability.	- Lectures followed by discussion - Participatory question-answer	
CLO5	Livelihood analysis, case study.	- Lectures followed by discussion - Participatory question-answer	
CLO6	Livelihood assets of the fishermen households.	- Lectures followed by discussion - Participatory question-answer	
CLO7	Char fisheries livelihood.	- Lectures followed by discussion - Participatory question-answer	
CLO8	Floodplain and coastal fisheries in livelihood development.	- Lectures followed by discussion - Participatory question-answer	
CLO9	Sustainable livelihood approaches and government perspective.	- Lectures followed by discussion - Participatory question-answer	
CLO10	Livelihood strategies, process, and outcomes.	- Lectures followed by discussion - Participatory question-answer	

Recommended books/literature:

1. Livelihood from Fishing, Globalization and sustainable fisheries policies. Alain Le Sann (Ed), 1998. Practical Action Publishing Ltd Company, England.
2. Fish and cassava are equally important in livelihood strategies of women in Mweru-Luapula Fishery, Aarnink, B.H.M. (1997). DoF/ML/1997/Report no. 40. Nchelenge, Zambia, Department of Fisheries.
3. Fisheries and livelihood in Tungabhadra Basin, India: Current status and Future possibilities. Manasi S, Lathe N, Raju K V (2009). The institute for social and Economic change, Bangalore, India.
4. Open water fisheries of Bangladesh. Payne AI. In: Tsai, C. and Ali M. A. (Eds.) 1997, The university press limited Dhaka.
5. In: Mountain fisheries challenges and opportunity for livelihood security. Sarma D, Bhagawati K, Akhtar MS.

0831-627: Aquarium Fish Culture

Credit: 2

Full Marks: 100 [Theory 70, Class Test (Written and/or Oral) 20 and Attendance 10]

Time: 3 hours (Seven questions to be set and five to be answered)

Course Description:

This course is an optional theoretical course to complete one and half years M.S. in Aquaculture degree. The course deals with the culture and breeding of aquarium fishes. The course includes a wide range of aspects such as, construction of aquarium tanks, maintenance of aquarium, preparation of feed and feeding management, management of water quality and disease.

Learning Outcomes:

At the end of the course, the students will be able to: i) familiarize with the aquarium fish culture practices; ii) provide solutions to the problems of on- going aquarium fish culture operations; iii) perform breeding of aquarium fishes.

At the end of the course, the students will able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Explain the introductory aspects, rationale, and expected outcome.	1
CLO2	Describe the history and importance of Aquarium fish culture, enlist important aquarium species (indigenous and exotic).	3
CLO3	Describe and prepare aquarium of different type and size.	3
CLO4	Perform maintenance of aquarium.	3
CLO5	Practice and manage food and feeding of aquarium fish.	3
CLO6	Perform and manage breeding of Aquarium species.	4
CLO7	Manage displaying of aquarium.	2
CLO8	Manage and suggest health problems of aquarium fishes.	3

Mapping CLOs with PLOs

CLOs	PLOs			
	PLO1	PLO2	PLO3	PLO4
CLO1	X	X	X	●
CLO2	X	X	X	●
CLO3	X	X	X	●
CLO4	X	X	X	●
CLO5	X	X	X	●
CLO6	X	X	X	●
CLO7	X	X	X	●
CLO8	X	X	X	●

X Strong contribution ● Weak contribution □ No contribution

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Introduction, rationale, and expected outcome.	- Lectures followed by discussion - Participatory question-answer	Full Marks: 100 (Theory: 70, Class Test: 20 & Attendance: 10)
CLO2	History and importance of Aquarium fish culture, important species (indigenous and exotic).	- Lectures followed by discussion - Participatory question-answer	
CLO3	The Aquarium: Types and size, preparation, photosynthesis, decomposition, and aeration.	- Lectures followed by discussion - Participatory question-answer	
CLO4	Maintenance of the Aquarium: Biological filler and water exchange; handling of Aquarium species Biological filters pruning and manuring plants, removing dust and	- Lectures followed by discussion - Participatory question-answer	

	sediments, disinfection.		
CLO5	Food and feeding: Life food, artificial feed, feeding regime, waste removal.	- Lectures followed by discussion - Participatory question-answer	
CLO6	Breeding of aquarium species: Brood selection, conditioning, breeding, fry rearing.	- Lectures followed by discussion - Participatory question-answer	
CLO7	Showing: Choosing and preparing fish for show, show standards.	- Lectures followed by discussion - Participatory question-answer	
CLO8	Health management of aquarium fishes.	- Lectures followed by discussion	

Recommended books/literature:

1. Mohsin ABM, Galib SM. Handbook on exotic ornamental fishes of Bangladesh: an identifying tool. Bangladesh Fisheries Information Share Home, Rajshahi, Bangladesh. 2013, 44.
2. Wabnitz C, Taylor M, Green E, Razak T. From Ocean to Aquarium. UNEP-WCMC, Cambridge, UK, 2003.
3. Ghosh, A., Mahapatra, B.K. and Datta, N.C.2000. Ornamental fish farming- an additional income generating programme for women folk with a note on its constraints and prospects, the Fifth Indian Fisheries Forum, Asian Fisheries Society, Central Institute of Freshwater Aquaculture (ICAR), Bhubaneswer.
4. Mahapatra, B.K., Ghosh, A. and Datta, N.C. 2000. Breeding and rearing of ornamental fishes, Guppy, Poeciliareticulata, Peter and Gold fish, Carassiusauratus (Linnaeus) for prospective entrepreneurship development. Green Technology. Vol.3. PP 26-33.

0831-628: Fish Immunology

Credit: 2

Full Marks: 100 [Theory 70, Class Test (Written and/or Oral) 20 and Attendance 10]

Time: 3 hours (Seven questions to be set and five to be answered)

Course Description:

This course is an optional theoretical course to complete one and half years M.S. in Aquaculture degree. The course covers the understanding of immune system and immunological mechanisms of fish. The course designed to develop knowledge of interactions between fish and pathogen, and courses of immunity development in fish body. This course can also teach immunological technique to disease diagnosis and disease protection. This course will also be focused on immunoassays, immunostimulation, immunosuppression and immunomodulators as environmental immunological aspects.

Learning Outcomes:

At the end of the course, the students will be able to understand the immune system and mechanisms of immunological responses in fish.

At the end of the course, the students will be able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe rationale and importance of studying fish immunology.	1
CLO2	Outline terminology, and the role of immunity in preventing infectious diseases.	3
CLO3	Explain non-specific immunity of fish.	3
CLO4	Explain specific immunity of fish.	3
CLO5	Understand and explain antibody probes.	3
CLO6	Describe principles of immunodiagnoses.	3
CLO7	Describe and suggest immunization and vaccination.	3
CLO8	Explain and manage environmental factors in maintaining fish health (Immunological aspects).	2

Mapping CLOs with PLOs

CLOs	PLOs			
	PLO1	PLO2	PLO3	PLO4
CLO1	X	X	X	●
CLO2	X	X	X	●

CLO3	X	X	X	●
CLO4	X	X	X	●
CLO5	X	X	X	●
CLO6	X	X	X	●
CLO7	X	X	X	●
CLO8	X	X	X	●

X Strong contribution ● Weak contribution □ No contribution

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Introduction, rationale and expected outcome.	Lectures followed by discussion	Full Marks: 100 (Theory: 70, Class Test: 20 & Attendance: 10)
CLO2	Introduction to fish immunology: Terminology, the role of immunity in preventing infectious diseases.	Lectures followed by discussion Online resources	
CLO3	Non-specific immunity in fish: Physical factors; humoral factors, cellular factors; inflammation and melano-macrophage centre (MMC).	Lectures followed by discussion Online resources	
CLO4	Specific immunity of fish: Structure, type and function of immunoglobins, mechanisms of immunoglobulin formation and their role in specific immunity; B and T Lymphocytes, helper and killer cells.	Lectures followed by discussion Online resources	
CLO5	Antibody probes: Polyclonal and monoclonal antibodies; hybridoma technology and preparation of monoclonal and polyclonal antibody.	Lectures followed by discussion Online resources	
CLO6	Principles of immunodiagnoses: Application of antibody probes in diagnosis of diseases. Immunodiagnostic techniques - agglutination, enzyme labelled antibody technique, indirect fluorescent antibody technique, enzyme-linked immunosorbent assay; immunohistochemistry and Western blot analysis.	Lectures followed by discussion Online resources	
CLO7	Immunization and vaccination: Active and passive immunisation; types of vaccine and vaccination. Fish vaccines, use of adjuvant and immunostimulants, the effectiveness of a vaccine, advantages of vaccination over chemotherapy, prospects of vaccine development.	Lectures followed by discussion Online resources	
CLO8	Immunological aspects: Immunoassays, immunostimulation, immunosuppression, immunoreversion and immunomodulators.	Lectures followed by discussion Online resources	

Recommended books/literature:

1. Anderson, D. P. 1974. Fish Immunology: A book in the series of Disease of fishes. F. H. publications, Inc. Ltd. Great Britain.
2. Iwame, G. and T. Nakanishi (eds). 1996. The Fish Immune System. Academic press.
3. Roitt, I.M. 1983. Essential Immunology (4th ed. reprinted). Blackwell Scientific Publication, Butler and Tannen Ltd. Rome,

4. Stolen, J.S., T.C. Fletcher, D.P. Adrerson, B.S. Rohrson, W. B. Van Muiswinkel 1993. Techniques in Fish Immunology.

0831-629: Aquaculture Impact

Credit: 2

Full Marks: 100 [Theory 70, Class Test (Written and/or Oral) 20 and Attendance 10]
Time: 3 hours (Seven questions to be set and five to be answered)

Course Description:

This course is an optional theoretical course to complete one and half years M.S. in Aquaculture degree. This course introduces the major sources of aquaculture impacts and their effects on the environment. The course will deal in depth with the impact of intensive aquaculture on wild fish populations, including the transfer of disease and parasites; and the impact of escaped exotic fish.

Learning Outcomes:

At the end of the course, the students will be able to i) understand the immune system and mechanisms of immunological responses in fish.

At the end of the course, the students will be able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Explain and describe environmental impact of aquaculture.	3
CLO2	Explain and describe impact of aquaculture on environment.	3
CLO3	Identify and discuss waste production in aquaculture.	3
CLO4	Describe and take measure for waste minimization.	3
CLO5	Describe and perform waste water treatment.	3
CLO6	Identify, describe and express own opinion in a concise manner to solve socio-economic impacts.	3
CLO7	Develop an independent opinion in waste minimization based on scientific information	3

Mapping CLOs with PLOs

CLOs	PLOs			
	PLO1	PLO2	PLO3	PLO4
CLO1	X	X	X	●
CLO2	X	X	X	●
CLO3	X	X	X	●
CLO4	X	X	X	●
CLO5	X	X	X	●
CLO6	X	X	X	X
CLO7	X	X	X	X

X Strong contribution ● Weak contribution □ No contribution

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Environmental impact of aquaculture: Introduction, aquaculture wastes, environmental consequences of hypernutrfication and eutrophication.	- Lectures followed by discussion - Online resources	**Full Marks: 100** (Theory: 70, Class Test: 20 & Attendance: 10)
CLO2	Impact of aquaculture on environment: Chemicals used in aquaculture, administration, environmental concerns and their effects on microbial community and environment.	- Lectures followed by discussion - Online resources	
CLO3	Waste production in aquaculture: Feed	- Lectures followed by discussion	

	derived and metabolic waste products, wastes from food and foodstuffs, methods of measuring waste production and fertilizer-derived wastes.	- Online resources	
CLO4	Waste minimization: Waste minimization and aquaculture planning. Environmental impact assessment. Operational management for waste reduction.	- Lectures followed by discussion - Online resources	
CLO5	Waste water treatment - physical methods: Solid removal, sedimentation, floatation, sludge denaturing and disposal. Interception of solids from floating net cage aquaculture. Pathogen elimination from waste water. Oxygenation. Wastewater treatment-biological methods: implication, design and management and application of biofilters in aquaculture.	- Lectures followed by discussion - Online resources	
CLO6	Socio- economic impacts: Impacts of aquaculture on socio-economic condition of the community.	- Lectures followed by discussion - Online resources	
CLO7	Future developments in waste minimization: Integrated farming systems development. Systems optimization and chemical usage. A strategic frame work for environmental management in aquaculture.	- Lectures followed by discussion - Online resources	

Recommended books/literature:

1. Climate change implications for fisheries and aquaculture. (2009), fisheries and aquaculture technical paper-530.
2. Ecoscience: Population, Resources, EnvironmentBy John P. Holdren; Paul R. Ehrlich; Anne H. EhrlichW. H. Freeman, 1977.
3. Aquacultural Development: Social Dimensions of an Emerging IndustryBy Conner Bailey; SveinJentoft; Peter SinclairWestview Press, 1996.
4. Aquaculture: Models and Economics by Upton Hatch; Henry KinnucanWestview Press, 1993.
5. Environmental Impacts of Aquaculture, Kenneth D. Black Sheffield Academic Press, 2001.

Research Work

0831-630: Research Defence-2

Credit: 2

Full Marks: 100

Students will face defence based on their research progress or findings of the research work.

Expected Outcomes:

At the end of the research progress presentation, the students will be able to respond comments and questions from the peers and faculties about their research efforts and can identify strength and weakness in ongoing research and presentations.

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0831-721: Thesis

Credit: 8

Full Marks: 100 (Abstract-10, Introduction-25, Methodology-20, Results and Discussion-20, Conclusion and Recommendation-5 and References-20 Marks).

Thesis may be consisting of Abstract, introduction (including problem statement, hypothesis, importance, objectives, limitations, and review of literature), methodology, results & discussion, conclusion & recommendation, and reference cited.

Expected Outcomes:

At the end of the writing thesis, the student will demonstrate their ability to conduct own research project, select relevant literature, apply methodologies, process and analysis of data, make critical interpretation and answer to questions raised in the problem statement.

0831-722: Thesis Defence

Credit: 4

Full Marks: 100

Students will face defence based on research findings including problem statement, hypothesis, importance, objectives, limitations, methodology, results & discussion, and recommendation.

Expected Outcomes:

At the end of the writing thesis, the student will be able to i) present research findings in brief ii) develop their presentation skills iii) develop skills to accept and response to relevant and constructive feedback in a meaningful way.

Part D

20. Grading/Evaluation:

Eligibility for the semester final examination:

Candidates having less than 60% attendance will not be allowed to fill up the examination form. Candidates having less than 75% to 60% attendance will be allowed to fill up the examination form on special grounds on such documentary evidence and the approval of special permission of Academic Committee but students will have to pay in addition to the examination fees, the requisite fee prescribed by the syndicate for the purpose. Attendance marks will be allotted based on the following Table –

Earned Percentage*	90 and above	85 to less than 90	80 to less than 85	75 to less than 80	70 to less than 75	65 to less than 70	60 to less than 65	less than 60
Marks	10	9	8	7	6	5	4	0

* Earned percentage should be calculated in the round figure according to the regular statistical method.

Semester final results will be published in GPA out of 4 on the basis of all courses and final result for the MS in Aquaculture degree will be published in CGPA out of 4 on the basis of all semester final examinations.

Grades will be awarded in accordance with provisions shown in the table as –

Numerical grade*	Letter Grade	Grade Point
80% or its above	A^+ (A plus)	4.00
75% to less than 80%	A (A regular)	3.75
70% to less than 75%	A^- (A minus)	3.50
65% to less than 70%	B^+ (B plus)	3.25
60% to less than 65%	B (B regular)	3.00
55% to less than 60%	B^- (B minus)	2.75
50% to less than 55%	C^+ (C plus)	2.50
45% to less than 50%	C (C regular)	2.25
40% to less than 45%	D	2.00
Less than 40%	F	0.00
Incomplete**	I	-

* Earned numerical grade should be calculated in round figure (once in a course) according to roundup statistical method.

** Absence from the final examination will be considered as incomplete with the letter grade "I".