Department of Fisheries
Faculty of Fisheries

Curriculum
for
B. Sc. Fisheries (Honours)
Session: 2023-2024

B. Sc. Fisheries (Honours) 1st Year 1st Semester Examination, January-June 2024
B. Sc. Fisheries (Honours) 1st Year 2nd Semester Examination, July-December 2024
B. Sc. Fisheries (Honours) 2nd Year 1st Semester Examination, January-June 2025
B. Sc. Fisheries (Honours) 2nd Year 2nd Semester Examination, July-December 2025
B. Sc. Fisheries (Honours) 3rd Year 1st Semester Examination, January-June 2026
B. Sc. Fisheries (Honours) 3rd Year 2nd Semester Examination, July-December 2026
B. Sc. Fisheries (Honours) 4th Year 1st Semester Examination, January-June 2027
B. Sc. Fisheries (Honours) 4th Year 2nd Semester Examination, July-December 2027

University of Rajshahi
Rajshahi, Bangladesh

Curriculum for B. Sc. Fisheries (Honours)
Session: 2023-2024

Part A

1. **Title of the Academic Programme:** B. Sc. Fisheries (Honours)
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 Programme Offering Entity (POE):**
   Department of Fisheries, Faculty of Fisheries, University of Rajshahi, Bangladesh.
6. **Vision of the Programme Offering Entity (POE):**

   Vision of the B. Sc. Fisheries (Honours) Programme

   To produce quality graduates who can lead the fisheries education, research and development world-wide.

7. **Mission of the Programme offering Entity (POE):**

   Mission of the B. Sc. Fisheries (Honours) Programme

   a. To achieve academic and research excellence in fisheries and aquaculture through state-of-the-art infrastructure and skilled academics.

   b. To produce globally competitive fisheries graduates who are capable of effective utilization of the aquatic resources, solving the community problems and contributing to sustainable development.

   c. To build communication and networking with different agencies through training and in field experience for self-employment and getting jobs in different national and international organizations.

Objective of the Programme Offering Entity (POE)

To offer fisheries education to obtain Bachelor of Science in 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.

8. Name of the Degree: B. Sc. Fisheries (Honours)

9. Description of the Programme:

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 staff 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 forty eight theoretical, fifty one practical and 4 viva-voce courses on different fields of fisheries in the undergraduate level including biology, breeding, ecology, management, aquaculture, nutrition, harvest and post-harvest technology etc. Moreover, internship is offered at the last semester to the students for obtaining field-oriented experience in fisheries sector of Bangladesh.

The B.Sc. Fisheries (Honours) degree is an integrated course of four academic years (four levels, eight semesters) will consist of Fisheries and relevant courses such as Biochemistry, Statistics, Sociology, Economics and Geography. It covers a total of 155 credits of which 37 credits in 1^{st} Year (1^{st} and 2^{nd} Semester), 37 credits in 2^{nd} Year (1^{st} and 2^{nd} Semester), 38 credits in 3^{rd} Year (1^{st} and 2^{nd} Semester) and 43 credits in 4^{th} Year (1^{st} and 2^{nd} Semester). In 4^{th} Year 2^{nd} semester, an internship (In Plant Attachment) course consists of 3 credits is included along with other courses.

The programme of study for the degree of B.Sc. Fisheries (Honours) will extend over a minimum period of four academic years. The degree will be completed within a maximum period of six academic years from the date of admission. No student will be allowed to stay for more than two consecutive terms in the same semester/year. The final examinations of the 1^{st} semester of 1^{st}, 2^{nd} and 3^{rd} year covers 6 theoretical and 6 practical courses and the 2^{nd} semester of both 1^{st} and 2^{nd} year covers 6 theoretical, 6 practical and 1 viva-voce courses. On the other hand, 2^{nd} semester of 3^{rd} year covers 6 theoretical, 6 practical, 1 viva-voce and 1 excursion courses, 4^{th} year 1^{st} semester covers 6 theoretical, 6 practical and 1 research work courses and 4^{th} year 2^{nd} semester covers 6 theoretical, 7 practical, 1 viva-voce and 1 internship courses.

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

10. Programme Educational Objective (PEOs):

Programme Educational Objectives (PEO) of the B. Sc. Fisheries (Honours) Programme

PEO1: To provide theoretical and practical knowledge on core and emerging disciplines of fisheries science.

PEO2: To conduct basic and applied research in different aspects of fisheries science.

PEO3: To provide need based extension support for different stakeholders in fisheries sector.

PEO4: To provide in field experience and training through networking with different organizations in fisheries sector.

PEO5: To develop knowledge and skills for solving fisheries community problems and providing services.

11. Programme Learning Outcomes (PLOs) At the end of the B. Sc. Fisheries (Honours) programme, the students will be able to-

PLOs	Programme Outcomes (PLOs)
PLO1	Apply knowledge and critical understanding of the well-established principles in the broad area of Fisheries
PLO2	Exercise civic rights and obligation at all levels as well as participating in for the improvement/development of fisher associations/societies and Bangladesh society at large
PLO3	Demonstrate techno-managerial professional knowledge and practical skills in Fisheries to lead a team in inexperienced environment
PLO4	Apply social, professional, environmental and ethical practice/values at work and in the daily life
PLO5	Demonstrate global knowledge and competencies to fulfil employment, entrepreneurial and lifelong learning skills towards development of Fisheries sector

12. Mapping between University mission and PEO

Mission	Programme Educational Objectives (PEOs)				
	PEO1	**PEO2**	**PEO3**	**PEO4**	**PEO5**
M1	X	X	X	●	●
M2	X	●	X	X	X
M3	X	X	●	X	●

X Strong contribution ● Weak contribution □ No contribution

13. Mapping between PEO and PLO

PLOs	PEOs				
	PEO1	PEO2	PEO3	PEO4	PEO5
PLO1	X	X	●	X	X
PLO2	X	●	X	X	X
PLO3	X	X	X	X	X
PLO4	X	●	X	X	X
PLO5	X	X	X	X	X

X Strong contribution ● Weak contribution □ No contribution

14. Mapping courses with PLOs

1st year

Course Code	Course Title	PLOs				
		PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**
0831-1101	Introduction to Fisheries Resources	X	X	X	X	X
0831-1102	General Ichthyology – I	X	●	X	X	X
0831-1103	Fisheries Zoology	X	●	X	X	X
0831-1104	Freshwater Ecology	X	X	X	X	X
0831-1105	General Microbiology	X	●	X	X	X
0831-1106	Biochemistry	X	●	X	X	X
0831-1111	Practical on Introduction to Fisheries Resources	X	X	●	X	X
0831-1112	Practical on General Ichthyology - I	X	●	X	X	X
0831-1113	Practical on Fisheries Zoology	X	●	X	X	X
0831-1114	Practical on Freshwater Ecology	X	X	X	X	X
0831-1115	Practical on General Microbiology	X	●	X	X	X
0831-1116	Practical on Biochemistry	X	●	X	X	X
0831-1201	Developmental Biology	X	X	●	X	X

Course Code	Course Title	PLOs				
		PLO1	PLO2	PLO3	PLO4	PLO5
0831-1202	General Ichthyology -II	X	●	X	X	X
0831-1203	Fundamentals of Aquaculture	X	X	X	X	X
0831-1204	Coastal and Marine Ecology	X	X	X	X	X
0831-1205	Physico-chemical Limnology	X	●	X	X	X
0831-1206	Fisheries Microbiology	X	●	X	X	X
0831-1211	Practical on Developmental Biology	X	X	●	X	X
0831-1212	Practical on General Ichthyology - II	X	●	X	X	X
0831-1213	Practical on Fundamentals of Aquaculture	X	X	X	X	X
0831-1214	Practical on Coastal and Marine Ecology	X	X	X	X	X
0831-1215	Practical on Physico-chemical Limnology	X	●	X	X	X
0831-1216	Practical on Fisheries Microbiology	X	●	X	X	X
0831-1221	Viva-voce	X	X	X	X	X

2nd year

Course Code	Course Title	PLOs				
		PLO1	PLO2	PLO3	PLO4	PLO5
0831-2101	Fish Physiology	X	●	X	X	X
0831-2102	Molecular Biology and Histology	X	●	X	X	X
0831-2103	Fish Behaviour	X	●	X	X	X
0831-2104	Fish Nutrition	X	X	X	X	X
0831-2105	Fish Parasitology	X	X	X	X	X
0831-2106	Fish Food Chemistry	X	X	X	X	X
0831-2111	Practical on Fish Physiology	X	●	X	X	X
0831-2112	Practical on Molecular Biology and Histology	X	●	X	X	X
0831-2113	Practical on Fish Behaviour	X	●	X	X	X
0831-2114	Practical on Fish Nutrition	X	X	X	X	X
0831-2115	Practical on Fish Parasitology	X	X	X	X	X
0831-2116	Practical on Fish Food Chemistry	X	X	X	X	X
0831-2201	Biological Limnology	X	X	X	X	X
0831-2202	Fisheries Systematics	X	●	X	X	X
0831-2203	Freshwater Aquaculture	X	X	X	X	X
0831-2204	Aquaculture Nutrition	X	X	X	X	X
0831-2205	Fishing Technology	X	X	X	X	X
0831-2206	Biostatistics	X	●	X	X	X
0831-2211	Practical on Biological Limnology	X	X	X	X	X
0831-2212	Practical on Fisheries Systematics	X	●	X	X	X
0831-2213	Practical on Freshwater Aquaculture	X	X	X	X	X

Course Code	Course Title	PLOs				
		PLO1	PLO2	PLO3	PLO4	PLO5
0831-2214	Practical on Aquaculture Nutrition	X	X	X	X	X
0831-2215	Practical on Fishing Technology	X	X	X	X	X
0831-2216	Practical on Biostatistics	X	●	X	X	X
0831-2221	Viva-voce	X	X	X	X	X

3rd year

Course Code	Course Title	PLOs				
		PLO1	PLO2	PLO3	PLO4	PLO5
0831-3101	Coastal Aquaculture and Mariculture	X	X	X	X	X
0831-3102	Principle of Fish Genetics	X	●	X	X	X
0831-3103	Fish Pathology and Immunology	X	●	X	X	X
0831-3104	Fisheries Post-Harvest Handling and Preservation	X	X	X	X	X
0831-3105	Oceanography	X	X	X	X	X
0831-3106	Rural Sociology and Fisheries Economics	X	X	X	X	X
0831-3111	Practical on Coastal Aquaculture and Mariculture	X	X	X	X	X
0831-3112	Practical on Principle of Fish Genetics	X	●	X	X	X
0831-3113	Practical on Fish Pathology and Immunology	X	●	X	X	X
0831-3114	Practical on Fisheries Post-Harvest Handling and Preservation	X	X	X	X	X
0831-3115	Practical on Oceanography	X	X	X	X	X
0831-3116	Practical on Rural Sociology and Fisheries Economics	X	X	X	X	X
0831-3201	Fish Hatchery Management	X	X	X	X	X
0831-3202	Fish Population Dynamics	X	●	X	X	X
0831-3203	Fish Feed Technology	X	●	X	X	X
0831-3204	Fish Processing	X	●	X	X	X
0831-3205	Genetics and Fish Breeding	X	X	X	X	X
0831-3206	Geographic Information System (GIS) and Remote Sensing	X	●	X	X	X
0831-3211	Practical on Fish Hatchery Management	X	X	X	X	X
0831-3212	Practical on Fish Population Dynamics	X	●	X	X	X
0831-3213	Practical on Fish Feed Technology	X	●	X	X	X
0831-3214	Practical on Fish Processing	X	●	X	X	X
0831-3215	Practical on Genetics and Fish Breeding	X	X	X	X	X
0831-3216	Practical on Geographic Information System (GIS) and Remote Sensing	X	●	X	X	X
0831-3217	Excursion	X	X	X	X	X
0831-3221	Viva-voce	X	X	X	X	X

4th year

Course Code	Course Title	PLOs				
		PLO1	PLO2	PLO3	PLO4	PLO5
0831-4101	Feed Manufacture and Live Feed Culture	X	X	X	X	X
0831-4102	Fisheries Resources Management	X	X	X	X	X
0831-4103	Fishery Byproducts Technology	X	●	X	X	X
0831-4104	Fish Stock Assessment	X	●	X	X	X
0831-4105	Fisheries Extension	X	X	X	X	X
0831-4106	Research Methodology	X	●	X	X	X
0831-4111	Practical on Feed Manufacture and Live Feed Culture	X	X	X	X	X
0831-4112	Practical on Fisheries Resources Management	X	X	X	X	X
0831-4113	Practical on Fishery Byproducts Technology	X	●	X	X	X
0831-4114	Practical on Fish Stock Assessment	X	●	X	X	X
0831-4115	Practical on Fisheries Extension	X	X	X	X	X
0831-4116	Practical on Research Methodology	X	●	X	X	X
0831-4117	Research Work	X	X	X	X	X
0831-4201	Aquaculture Engineering and Farm Management	X	X	X	X	X
0831-4202	Fish Health Management and Pharmacology	X	X	X	X	X
0831-4203	Aquatic Pollution and Toxicology	X	X	X	X	X
0831-4204	Aquatic Biodiversity and Conservation	X	X	X	X	X
0831-4205	Fish Inspection and Quality Control	X	X	X	X	X
0831-4206	Fisheries Marketing	X	●	X	X	X
0831-4211	Practical on Aquaculture Engineering and Farm Management	X	X	X	X	X
0831-4212	Practical on Fish Health Management and Pharmacology	X	X	X	X	X
0831-4213	Practical on Aquatic Pollution and Toxicology	X	X	X	X	X
0831-4214	Practical on Aquatic Biodiversity and Conservation	X	X	X	X	X
0831-4215	Practical on Fish Inspection and Quality Control	X	X	X	X	X
0831-4216	Practical on Fisheries Marketing	X	●	X	X	X
0831-4217	Practical on Participatory Rural Appraisal (PRA) Tools	X	X	X	X	X
0831-4218	Internship (In-plant attachment)	X	X	X	X	X
0831-4221	Viva-voce	X	X	X	X	X

X Strong contribution ● Weak contribution ☐ No contribution

Part B

15. Structure of the curriculum

a) **Duration of the Programme:** Eight semesters (four academic years)

b) **Admission requirements**: as per University of Rajshahi rules and regulation.

c) **Total minimum credit requirement to complete the Programme:** 155

d) **Total class weeks in a semester:** Total 14 class weeks including class tests (2 weeks) in a semester

e) **Minimum CGPA requirements for graduation:** 2.50

f) **Maximum academic years of completion:** Six academic years from the date of admission

g) Category of courses:

I. **General Education Courses:** Fisheries Zoology, Molecular Biology, Developmental biology, General microbiology, Fisheries Microbiology, Freshwater ecology, Aquatic Biodiversity and Conservation, Coastal and marine ecology, Biochemistry, Principles of Fish Genetics, Rural Sociology and Fisheries Economics, Fisheries Marketing, GIS and Remote Sensing, Fisheries Extension, Biostatistics and Research Methodology.

II. **Core Courses:** Introduction to Fisheries Resources, General Ichthyology – I, General Ichthyology –II, Fundamentals of Aquaculture, Physico-chemical Limnology, Fish Physiology, Fish Behaviour, Fish Nutrition, Fish Parasitology, Fish Food Chemistry, Biological Limnology, Fisheries Systematics, Freshwater Aquaculture, Aquaculture Nutrition, Fishing Technology, Coastal Aquaculture and Mariculture, Fish Pathology and Immunology, Fisheries Post-Harvest Handling and Preservation, Genetics and Fish Breeding, Oceanography, Fish Hatchery Management, Fish Population Dynamics, Fish Feed Technology, Fish Processing, Feed Manufacture and Live Feed Culture, Fisheries Resources Management, Fishery Byproducts Technology, Fish Stock Assessment, Aquaculture Engineering and Farm Management, Fish Health Management and Pharmacology, Aquatic Pollution and Toxicology, Fish Inspection and Quality Control etc.

III. **Elective Courses:** None

IV. Excursion

V. **Internship:** in-plant attachment; and

VI. **Thesis:** based on research work.

16. Distribution of courses

Detailed break up of courses

B. Sc. Fisheries (Honours) 1st Year 1st Semester Examination, January-June 2024

Theory		
Course Code	**Course Title**	**Credit**
0831-1101	Introduction to Fisheries Resources	2
0831-1102	General Ichthyology – I	2
0831-1103	Fisheries Zoology	2
0831-1104	Freshwater Ecology	2
0831-1105	General Microbiology	2
0831-1106	Biochemistry	2
	Total	**12**
Practical		
Course Code	**Course Title**	**Credit**
0831-1111	Practical on Introduction to Fisheries Resources	1
0831-1112	Practical on General Ichthyology - I	1
0831-1113	Practical on Fisheries Zoology	1
0831-1114	Practical on Freshwater Ecology	1
0831-1115	Practical on General Microbiology	1
0831-1116	Practical on Biochemistry	1
	Total	**6**
	Grand Total	**18**

B. Sc. Fisheries (Honours) 1st Year 2nd Semester Examination, July-December 2024

Theory		
Course Code	**Course Title**	**Credit**
0831-1201	Developmental Biology	2
0831-1202	General Ichthyology -II	2
0831-1203	Fundamentals of Aquaculture	2
0831-1204	Coastal and Marine Ecology	2
0831-1205	Physico-chemical Limnology	2
0831-1206	Fisheries Microbiology	2
	Total	**12**

Practical		
Course Code	**Course Title**	**Credit**
0831-1211	Practical on Developmental Biology	1
0831-1212	Practical on General Ichthyology - II	1
0831-1213	Practical on Fundamentals of Aquaculture	1
0831-1214	Practical on Coastal and Marine Ecology	1
0831-1215	Practical on Physico-chemical Limnology	1
0831-1216	Practical on Fisheries Microbiology	1
	Total	**6**
Viva-voce		
Course Code	**Course Title**	**Credit**
0831-1221	Viva-voce	1
	Grand Total	**19**

At the end of 1st Year

Semester		1st	2nd	**Total**
Number of Completed Courses	Theoretical	6	6	**12**
	Practical	6	6	**12**
	Viva-voce	0	1	**1**
	Total	**12**	**13**	**25**
Earned Credits	Theoretical	12	12	**24**
	Practical	6	6	**12**
	Viva-voce	0	1	**1**
	Total	**18**	**19**	**37**

B. Sc. Fisheries (Honours) 2nd Year 1st Semester Examination, January-June 2025

Theory		
Course Code	**Course Title**	**Credit**
0831-2101	Fish Physiology	2
0831-2102	Molecular Biology and Histology	2
0831-2103	Fish Behaviour	2
0831-2104	Fish Nutrition	2
0831-2105	Fish Parasitology	2
0831-2106	Fish Food Chemistry	2
	Total	**12**

Practical		
Course Code	**Course Title**	**Credit**
0831-2111	Practical on Practical on Fish Physiology	1
0831-2112	Practical on Molecular Biology and Histology	1
0831-2113	Practical on Fish Behaviour	1
0831-2114	Practical on Fish Nutrition	1
0831-2115	Practical on Fish Parasitology	1
0831-2116	Practical on Fish Food Chemistry	1
	Total	**6**
	Grand Total	**18**

B. Sc. Fisheries (Honours) 2nd Year 2nd Semester Examination, July-December 2025

Theory		
Course Code	**Course Title**	**Credit**
0831-2201	Biological Limnology	2
0831-2202	Fisheries Systematics	2
0831-2203	Freshwater Aquaculture	2
0831-2204	Aquaculture Nutrition	2
0831-2205	Fishing Technology	2
0831-2206	Biostatistics	2
	Total	**12**
Practical		
Course Code	**Course Title**	**Credit**
0831-2211	Practical on Biological Limnology	1
0831-2212	Practical on Fisheries Systematics	1
0831-2213	Practical on Freshwater Aquaculture	1
0831-2214	Practical on Aquaculture Nutrition	1
0831-2215	Practical on Fishing Technology	1
0831-2216	Practical on Biostatistics	1
	Total	**6**
Viva-voce		
Course Code	**Course Title**	**Credit**
0831-2221	Viva-voce	1
	Grand Total	**19**

At the end of 2nd Year

Semester		1st	2nd	Total
Number of Completed Courses	Theoretical	6	6	**12**
	Practical	6	6	**12**
	Viva-voce	0	1	**1**
	Total	**12**	**13**	**25**
Earned Credits	Theoretical	12	12	**24**
	Practical	6	6	**12**
	Viva-voce	0	1	**1**
	Total	**18**	**19**	**37**

B. Sc. Fisheries (Honours) 3rd Year 1st Semester Examination, January-June 2026

Theory		
Course Code	**Course Title**	**Credit**
0831-3101	Coastal Aquaculture and Mariculture	2
0831-3102	Principle of Fish Genetics	2
0831-3103	Fish Pathology and Immunology	2
0831-3104	Fisheries Post-Harvest Handling and Preservation	2
0831-3105	Oceanography	2
0831-3106	Rural Sociology and Fisheries Economics	2
	Total	**12**
Practical		
Course Code	**Course Title**	**Credit**
0831-3111	Practical on Coastal Aquaculture and Mariculture	1
0831-3112	Practical on Principle of Fish Genetics	1
0831-3113	Practical on Fish Pathology and Immunology	1
0831-3114	Practical on Fisheries Post-Harvest Handling and Preservation	1
0831-3115	Practical on Oceanography	1
0831-3116	Practical on Rural Sociology and Fisheries Economics	1
	Total	**6**
	Grand Total	**18**

B. Sc. Fisheries (Honours) 3rd Year 2nd Semester Examination, July-December 2026

Theory		
Course Code	**Course Title**	**Credit**
0831-3201	Fish Hatchery Management	2
0831-3202	Fish Population Dynamics	2
0831-3203	Fish Feed Technology	2
0831-3204	Fish Processing	2
0831-3205	Genetics and Fish Breeding	2
0831-3206	Geographic Information System (GIS) and Remote Sensing	2
	Total	**12**

Practical		
Course Code	**Course Title**	**Credit**
0831-3211	Practical on Fish Hatchery Management	1
0831-3212	Practical on Fish Population Dynamics	1
0831-3213	Practical on Fish Feed Technology	1
0831-3214	Practical on Fish Processing	1
0831-3215	Practical on Genetics and Fish Breeding	1
0831-3216	Practical on Geographic Information System (GIS) and Remote Sensing	1
0831-3217	Excursion	1
	Total	**7**

Viva-voce		
Course Code	**Course Title**	**Credit**
0831-3221	Viva-voce	1
	Grand Total	**20**

At the end of 3rd Year

Semester		1st	2nd	Total
Number of Completed Courses	Theoretical	6	6	**12**
	Practical	6	7	**13**
	Viva-voce	0	1	**1**
	Total	**12**	**14**	**26**
Earned Credits	Theoretical	12	12	**24**
	Practical	6	7	**13**
	Viva-voce	0	1	**1**
	Total	**18**	**20**	**38**

B. Sc. Fisheries (Honours) 4th Year 1st Semester Examination, January-June 2027

Theory		
Course Code	**Course Title**	**Credit**
0831-4101	Feed Manufacture and Live Feed Culture	2
0831-4102	Fisheries Resources Management	2
0831-4103	Fishery Byproducts Technology	2
0831-4104	Fish Stock Assessment	2
0831-4105	Fisheries Extension	2
0831-4106	Research Methodology	2
	Total	**12**
Practical		
Course Code	**Course Title**	**Credit**
0831-4111	Practical on Feed Manufacture and Live Feed Culture	1
0831-4112	Practical on Fisheries Resources Management	1
0831-4113	Practical on Fishery Byproducts Technology	1
0831-4114	Practical on Fish Stock Assessment	1
0831-4115	Practical on Fisheries Extension	1
0831-4116	Practical on Research Methodology	1
0831-4117	Research Work	2
	Total	**8**
	Grand Total	**20**

B. Sc. Fisheries (Honours) 4th Year 2nd Semester Examination, July-December 2027

Theory		
Course Code	**Course Title**	**Credit**
0831-4201	Aquaculture Engineering and Farm Management	2
0831-4202	Fish Health Management and Pharmacology	2
0831-4203	Aquatic Pollution and Toxicology	2
0831-4204	Aquatic Biodiversity and Conservation	2
0831-4205	Fish Inspection and Quality Control	2
0831-4206	Fisheries Marketing	2
	Total	**12**
Practical		
Course Code	**Course Title**	**Credit**
0831-4211	Practical on Aquaculture Engineering and Farm Management	1
0831-4212	Practical on Fish Health Management and Pharmacology	1
0831-4213	Practical on Aquatic Pollution and Toxicology	1
0831-4214	Practical on Aquatic Biodiversity and Conservation	1

0831-4215	Practical on Fish Inspection and Quality Control	1
0831-4216	Practical on Fisheries Marketing	1
0831-4217	Practical on Participatory Rural Appraisal (PRA) Tools	1
	Total	**7**
Internship		
Course Code	**Course Title**	**Credit**
0831-4218	Internship (In-plant attachment)	3
	Total	**3**
Viva-voce		
Course Code	**Course Title**	**Credit**
0831-4221	Viva-voce	1
	Grand Total	**23**

At the end of 4th year

Semester		1st	2nd	**Total**
Number of Completed Courses	Theoretical	6	6	**12**
	Practical	7	7	**14**
	Internship	0	1	**1**
	Viva-voce	0	1	**1**
	Total	**13**	**15**	**27**
Earned Credits	Theoretical	12	12	**24**
	Practical	8	7	**15**
	Internship	0	3	**3**
	Viva-voce	0	1	**1**
	Total	**20**	**23**	**43**

At the end of Undergraduate Programme

Year		**1st**	**2nd**	**3rd**	**4th**	**Total**
Number of Completed Courses	Theoretical	12	12	12	12	**48**
	Practical	12	12	13	14	**51**
	Internship	0	0	0	1	**1**
	Viva-voce	1	1	1	1	**4**
	Total	**25**	**25**	**26**	**27**	**104**
Earned Credits	Theoretical	24	24	24	24	**96**
	Practical	12	12	13	15	**52**
	Internship	0	0	0	3	**3**
	Viva-voce	1	1	1	1	**4**
	Total	**37**	**37**	**38**	**43**	**155**

Part C

17. Description of courses

Detailed Courses

B. Sc. Fisheries (Honours) 1st Year 1st Semester Examination, January-June 2024

Theoretical Courses

0831-1101: Introduction to Fisheries Resources

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and condition to complete B. Sc. in Fisheries (Honours) degree with 8 semesters. This course deals with basic concept of the fish, fishery, fisheries resources and classification of major fish orders with special reference to freshwater fishes of Bangladesh. This course will attempt to describe Freshwater, Estuary and Marine waterbodies of Bangladesh and their importance and contribution in fisheries sector. This course highlights to understand and identify the small Indigenous species (SIS), threatened fish species, ornamental fishes and exotic culturable species and their impact on aquatic habitat. This course is also designed to describe fisheries institutional resource in Bangladesh and their mandate and legal frame work and to interpret fisheries production statistics for promoting aquaculture resources in Bangladesh

Learning Outcomes:

At the end of the course, the students will be able to know about the classification of fish, commercially important fish and shellfish, threatened and exotic fishes, SIS species and present status of fisheries resources in Bangladesh.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe basic concept of fish, shellfish, fishery, fisheries (science and sector), capture and culture fisheries, aquaculture	2
CLO2	Classify major fish orders (Clupeiformes, Cypriniformes, Siluriformes, Perciformes) with special reference to freshwater fishes of Bangladesh.	4
CLO3	Describe different types and importance of fisheries resources. Distinguish Freshwater, Estuary and Marine waterbodies of Bangladesh.	3
CLO4	Discuss commercially important fish (Feather backs, Eels, Shads, Milk fishes, Snakeheads, Carps, Barbs, Minnows, Catfishes, Perches, Mullets, Gobies etc.) and shellfishes (Prawn and Shrimps, Crabs, Turtles,	3

	Crocodiles etc.)	
CLO5	Describe Cultivable fishes, threatened fishes, Ornamental fishes, exotic fishes, Small Indigenous Species (SIS) of Bangladesh and their present status including commercial status.	8
CLO6	Describe Fisheries institutional resource in Bangladesh and their mandate. Manpower (Scientific personnel, fishers, etc.), Cooperatives (GO, NGO etc.), fisheries legislation (policy and legal frame work) including Fisheries statistics (fish production performance, public and private sector fisheries infrastructure. consumption and export, aquaculture contribution, GDP etc.)	4

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	**PLOs**				
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**
CLO1	X	X	X	X	X
CLO2	X	●	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	●	X	X	X
CLO6	X	X	X	X	X

Lesson plan:

CLOs	**Course Contents**	**Teaching Strategy**	**Assessment Strategy**
CLO1	General concept of fish, shellfish, fishery, fisheries (science and sector), capture and culture fisheries, aquaculture	Lectures followed by discussion Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	Classification of Fishes: classification of major fish orders with special reference to freshwater bodies of Bangladesh. Clupeiformes, Cypriniformes, Siluriformes, Perciformes and others.	Lectures followed by discussion Participatory question-answer Online resources	
CLO3	Types and importance of fisheries resources: Physical, Biological and others fisheries resource.	Lectures followed by discussion Participatory question-answer Online resources	
CLO4	Freshwater, Estuary and Marine waterbodies of Bangladesh: Types, Characteristics, Importance. (floodplain, haors, baors, beels, Kaptai Lake etc.)	Lectures followed by discussion Participatory question-answer Online resources	

CLO4	Commercially important fish groups: Feather backs, Eels, Shads, Milk fishes, Snakeheads, Carps, Barbs, Minnows, Catfishes, Perches, Mullets, Gobies etc.	Lectures followed by discussion Participatory question-answer Online resources Video demonstration	
CLO4	Commercially important shellfish groups and other fisheries items: Prawn and Shrimps, Crabs, Turtles, Crocodiles etc.	Lectures followed by discussion Participatory question-answer Online resources	
CLO5	Exotic fishes of Bangladesh and their impact (origin, source, year of introduction, taxonomic position and identifying characteristics) in our ecosystem.	Lectures followed by discussion Participatory question-answer	
CLO5	Threatened fishes of Bangladesh (Vulnerable, endangered, Critically endangered, extinct species) and their present status.	Lectures followed by discussion Participatory question-answer	
CLO5	Small Indigenous Species (SIS), Cultivable fish species in fresh water habitat.	Lectures followed by discussion Participatory question-answer	
CLO5	Ornamental fishes of Bangladesh with emphasis on live bearing and egg laying species	Lectures followed by discussion Participatory question-answer	
CLO6	Fisheries institutional resourcein Bangladesh and mandate. Manpower (Scientific personnel, fishers, etc.), Cooperatives (GO, NGO etc.) and fisheries legislation (policy and legal frame work)	Lectures followed by discussion Participatory question-answer	
CLO6	Fisheries statistics (fish production performance, public and private sector fisheries infrastructure. consumption and export, aquaculture contribution, GDP etc) for promoting fisheries resources	Lectures followed by discussion Participatory question-answer	

Recommended literature:

1. Day F (1971) *The Fishes of India*. Today and Tomorrow Book Agency, New Delhi.
2. Kurian CV and Sebastian VO (1982) *Prawns and Prawn Fisheries of India*. Hindustan Publishing Corporation, Delhi-110007, India.
3. Misra KS (1962) An Aid to the identification of the common Commercial fishes of India and Pakistan. *Rec. Indian Mus.* 57: 1–320.

4. Nelson JS (2006) *Fishes of the World*. John Wiley and Sons. New York, Toronto, Sydney.
5. Rahman AKA (2005) *Freshwater Fishes of Bangladesh*, 2nd edition. Zool. Soc. Bangladesh, Dhaka.
6. Talwar PK and Jhingran AG (1991) *Inland Fishes of India and Adjacent Countries*. Volume 1 and 2, Oxford and IBH Publ. Co. Calcutta, India.

0831-1102: General Ichthyology - I

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course to complete 4-year B. Sc. Fisheries (Honours) degree. The course covers external and internal morphology of fishes *viz*. integumentary, circulatory, respiratory, excretory, osmoregulatory, and reproductive and urinogenital system of fishes along with its history and importance. The course mainly focuses on the proper feature on basic structure and function of fish body. The course will strengthen students' knowledge on fish morphology which is prerequisite to understand fisheries science.

Expected Outcomes:

At the end of the course, the students will be able to- i) know the various body form and structure of fish; ii) obtain proper knowledge on different organ systems of fish; iii) apply acquired knowledge in all aspects of studying fishery science.

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

CLOs	**Course Learning Outcomes**	**Lectures**
CLO1	Describe the history behind Ichthyology and explain its importance.	1
CLO2	Compare, identify and differentiate morphological features of fish body along with structural variation, function and derivatives of external organs.	8
CLO3	Demonstrate and compare types, structure and mode of blood circulatory system.	5
CLO4	Compare and explain the structure and function of respiratory organs in different fish groups.	5
CLO5	Explain the structure and function of excretory and osmoregulatory system along with mode of action.	5
CLO6	Apply acquired knowledge of reproductive and urinogenital system in practical field as well as operation a fish farm.	4

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	History and importance of Ichthyology.	-Lecture -Power point presentation	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	**External morphology:** body form, body coverings, integument, structure and function of skin; appendages and openings; scales- structure, shape, types, derivatives, functions; other derivatives of skin- glands, dermal fin rays, flaps and barbels; colouration.	-Lectures followed by discussion -Participatory question-answer -Power point presentation -Online resources	
CLO3	**Circulatory system:** definition, branchial and pulmonary circulation, afferent and efferent branchial systems, open and closed circulation; lymph and lymphatic system.		
CLO4	**Respiratory system:** Gills and air-breathing organs and structure of respiratory organs.		
CLO5	**Excretory and osmo-regulatory system:** Classification, structures and functions.		
CLO6	**Reproductive and urinogenital system:** definition, types and sexual dimorphism		

Recommended literature:

1. Aleev YG (Ed) (1969) Function and gross Morphology in Fish. Keter Press, Jerusalem.
2. Bone Q, Moore RH (2008) A Text Book of Fish Biology and Fisheries. Taylor & Francis Group, UK.
3. Datta Munshi JS and Hughes GM (1992) Air-breathing Fishes of India. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, Bombay, Calcutta.
4. Goodrish ES (1958) Studies on the Structures and development of vertebrate, Vols. I and II, Dover Publ., New York.

5. Gunther ACLG (1963) An Introduction to the studies of Fishes, Today and Tomorrows Book Agency, New Delhi.
6. Hyman LH (1961) Comparative Vertebrate Anatomy. The Chicago Univ. Press, USA.
7. Khanna SS and Singh HR (2006) A Text Book of Fish Biology and Fisheries, Narendra Publishing House, Delhi-110006, India.
8. Kumar S and Tembhre M (1998) Anatomy and Physiology of Fishes. Vikas Publishing House Pvt. Ltd., India.
9. Lagler KF (1952) Freshwater Fishery Biology. IOWA Press Inc. USA.
10. Lagler KF, Bardach JE, Miller RR and Passino DRM (1977) Ichthyology. John Wiley and Sons. New York.
11. Love MS and Cailliet GM (Eds) (1979) Reading in Ichthyology. Prentice –Hall of India Pvt. Ltd., New Delhi.
12. Marshall NB (1965) The Life of Fishes, Weidenfeid and Nicolson, London.
13. Poznanin LP (1977) Ichthyology. Amerind Publishing Co. Pvt. Ltd., New Delhi, Bombay, Calcutta, New York.
14. Romer AS (1949) The Vertebrate Body. W. B. Saunders Co., Philadelphia.
15. Schultz LP and Stern EM (1949) The Ways of Fishes, D. Van Nostrand Co. Inc., New York.
16. Stockard AH (1949) A Laboratory manual of Comparative anatomy of the Chordates, Edward Bros., Michigan.

0831-1103: Fisheries Zoology

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a theoretical course on zoology of fishes and other fisheries items and prerequisite to complete the 4-years B.Sc. in Fisheries (Honours) degree. The course covers classification, general morphology, mode of life, adaptation of fishes, amphibian, reptiles, birds and mammals. This course can also teach them about biological and economic importance of fishes and other fisheries items.

Learning Outcomes:

At the end of the course, the students will be able to: i) know the various types of fisheries invertebrate with their classification ii) know the general account of fisheries invertebrates and vertebrates found in Bangladesh with their adaptation in aquatic life iii) realize the biological and economic importance of those invertebrates and vertebrates for human being.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Know the classification of important invertebrate phyla with special reference to fisheries organisms found in Bangladesh.	5
CLO2	Know and distinguish the classification of important vertebrate classes with special reference to fisheries organisms found in Bangladesh.	5
CLO3	Discuss on the general morphology, mode of life, adaptation of protozoans, sponges, corals, aquatic arthropods, molluscs and echinoderms.	4
CLO4	Know and compare biological and economic importance protozoans, sponges, corals, aquatic arthropods, molluscs and echinoderms.	2
CLO5	Discuss general morphology, mode of life, adaptation of fishes, amphibian, reptiles, birds, mammals.	4
CLO6	Know and compare biological and economic importance of fishes, amphibian, reptiles, birds, mammals.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Classification of important invertebrate phyla with special reference to fisheries organisms found in Bangladesh.	Lectures followed by discussion Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	Classification of important vertebrate classes with special reference to fisheries organisms found in Bangladesh.		
CLO3	General morphology, mode of life, adaptation of protozoans, sponges, corals, aquatic arthropods, molluscs and echinoderms.		

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO4	Biological and economic importance protozoans, sponges, corals, aquatic arthropods, molluscs and echinoderms.		
CLO5	General morphology, mode of life, adaptation of amphibian, reptiles, birds, mammals.		
CLO6	Biological and economic importance of amphibian, reptiles, birds, mammals.		

Recommended literature:

1. General Zoology, T. I. Storer and R. L. Usinger (1965), McGraw Hill Book Co., New York.
2. Text Book of Zoology, Vol. I and II (7th edn.), T. G. Parker and W. S. Haswell (1960), McMillan Co. Ltd., London.
3. The Invertebrate, Vol. I-VI, L. H. Hymen (1940), McGraw Hill Publi. Co., New York.
4. The Invertebrate Zoology, J. G. Engemann and R. W. Hagner (1981), McMillan Publ. Co., New York.
5. Invertebrate Structure and Function, E. J.W. Barrington (1979), John Wiley and Sons., New York.
6. A Biology of Crustacea, J. Green (1961), Quadrangle Books Inc.
7. Invertebrate Zoology, E. L. Jordan and P. S. Verma (1985), S. Chand and Co., Ramnagar, New Delhi.
8. The Mollusca, Vol. I – V, Karl M. Wilbur (1983), Academic Press, New York, London.
9. The Handbook on Freshwater Molluscs of India (1989), Zoological Survey of India, Calcutta.
10. Molluscan Fauna of the Bay of Bengal: Marine Molluscs, A. T. A. Ahmed (1990), Dhaka.

0831-1104: Freshwater Ecology

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete 4-year B. Sc. in Fisheries (Honours) degree. The course covers freshwater habitat and organism and the relationship between these. The course is designed to strengthen the student's existing knowledge on different issues of freshwater environment. This course can also teach them about freshwater ecosystem and different

environmental factors which control this ecosystem. A number of further topics, like the, biogeochemical cycle, degradation issue of freshwater environment will be also focused in the course.

Expected Outcomes:

At the end of the course, the students will be able to: i) identify and differentiate the characteristics of the types of habitat and organism in a selected freshwater environment; ii) explain the relationship between the habitat and the biota in a freshwater environment.

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

CLOs	**Course Learning Outcomes**	**Lectures**
CLO1	Discuss about types, importance, scope and approaches of ecology; Describe basic terminology of ecology	4
CLO2	Explain environmental principles and their application in the field of fisheries resource management	2
CLO3	Discuss different issues of freshwater environment; Describe ecosystem, importance, modification and development of floodplain; Explore different aquatic habitats of Bangladesh	4
CLO4	Discuss about biogeochemical cycle of freshwater environment	4
CLO5	Explain different aspect of limiting factors of freshwater environment	3
CLO6	Describe degradation issues of aquatic environment and their impact on fish and fish habitat	3

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	**PLOs**				
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	**Ecology and environment:** Concept of environment, definition and types of ecology, ecology as a science of environment, history of ecology, importance, scope and approaches to the study of ecology. **Basic terminology related to ecology** (habitat, niche, ecosystem, food chain, food web, individual size and metabolism, law of thermodynamics, Liebig's law of minimum, Shelford's law of tolerance, energy flow, standing crop, carrying capacity, population, community, ecotone, edge species and edge effect etc.).	Lectures followed by discussion Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	**Principles:** environmental principles and their application in the field of fisheries resource management.	Lectures followed by discussion Participatory question-answer	
CLO3	**Freshwater environment:** Ecological classification of freshwater organisms; lakes, pools and other standing water bodies (lentic habitat); general models of production; running water (lotic habitat) communities; sources of food and energy flow in streams. **Flood plains:** Ecosystem of flood plains, flood plain fisheries, modification of floodplain ecosystems, recommendations for the development of floodplain ecosystem. Different aquatic habitats of Bangladesh (pond, river, beel, baor, jheel, daha, floodplain etc.).	Lectures followed by discussion Participatory question-answer Online resources Videos	
CLO4	**Biogeochemical cycle:** Nitrogen cycle, Phosphorus cycle, Silicon cycle and Carbon cycle.	- Lectures followed by discussion - Participatory question-answer	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO5	Limiting factors of freshwater environment: Physical and chemical limiting factors.	- Lectures followed by discussion - Participatory question-answer	
CLO6	Degradations of aquatic environment: causes, impact on aquatic resources	- Lectures followed by discussion -Participatory question-answer	

Recommended books/ literature:

1. Fundamentals of ecology by Odum, Eugene P. Philadelphia: W. B. Saunders Company, 1953. 383 P
2. Freshwater Ecology: concepts and environments by Walter, K., Dodds. Elsevier, India Pvt. Ltd., New Delhi, India.
3. Ecology of Running Waters. H. B. N. Hynes (1972). Liverpool Univ. Press.
4. Fisheries Ecology. T. 2. Pitcher and J. B. Hart (1982). Croom Helm.
5. The Life of Rivers and Streams. R. L. Usiager (1968). McGraw Hill Book Co. New York.
6. A Manual of Freshwater Ecology. R. Santharam, P. Velayutham and G. Jegatheesan (1989). Daya Publ. House, Delhi.
7. The Ecology of Tropical Lakes and Rivers. A. I. Payne. (1986). John Wiley and Sons. Chichester, New York, Toronto, Brisbane, Singapore.

0831-1105: General Microbiology

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete four years B.Sc. Fisheries (Honours) degree. The course coverers principles, philosophy, objectives, scope, potentials and problems of fisheries extension, communication, extension teaching methods and teaching aids, learning, PRA tools/techniques, group, organization, participatory extension activities, innovation decision process, leadership, program planning and evaluation. A number of further topics like, leadership, program planning and evaluation and rural youth will be also focused in the course. The course is designed to strengthen the student's existing knowledge on fisheries resources management.

Learning Outcomes:

At/by the end of the course, the students will be able to i) know about the ensure safety of fish and fishery products ii) Knowledge gained from this course will be useful for studying other courses like- Fish processing, Quality control, Fish pathology etc.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Define microbiology and understand its scope and branches, describe the history of microbiology.	4
CLO2	Classify and compare the microorganisms and discuss the distribution of microorganisms.	4
CLO3	Classify, understand and distinguish the yeast, classify, understand and distinguish molds.	4
CLO4	Classify, understand and distinguish the bacteria, Describe the morphology and illustrate the types of bacteria	6
CLO5	Classify, understand and distinguished the virus.	3
CLO6	Classify, understand and distinguished the aquatic microorganism.	3

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	**Introduction:** Definition of microbiology and microorganism; scope and history of microbiology, branches of microbiology; fisheries microbiology and its importance.	- Lectures followed by discussion - Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	**Distribution and classification of microorganisms:** Ecological distribution of microorganism, background of microbial classification, general characteristics of prokaryotes and eukaryotes, classification of fungus and bacteria.	- Lectures followed by discussion - Participatory question-answer	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO3	**Fungi (The eukaryotic microorganism):** Definition, morphology, physiological and cultural characteristics, reproduction, identification criteria of molds and yeast; characteristics of yeast and mold genera or groups important in food microbiology.	- Lectures followed by discussion -Participatory question-answer	
CLO4	**Bacteria (The prokaryotic microorganism):** Definition, morphology, physiological and cultural characteristics, reproduction, growth curve of bacteria; characteristics and description of bacterial genera or groups important in food microbiology.	- Lectures followed by discussion - Participatory question-answer	
CLO5	**Viruses (The sub-cellular microorganism):** Definition, structure, chemical composition, viral replication and important viruses.	- Lectures followed by discussion - Participatory question-answer	
CLO6	**Aquatic microorganisms:** Definition, influencing factors and economic significance of aquatic microorganisms; general characteristics of aquatic bacteria, inland and marine waters bacteria.	- Lectures followed by discussion - Participatory question-answer	

Recommended literature:

1. Microbiology - An introduction to protests, J. S. POINDEXTER
2. Food Microbiology. 3rd Edition, Frazier W. C. and D. C. Westhoff. 1990.McGraw Hill Book Co., New York, London. 502 pp.
3. A Text Book of Microbiology, Burrows.
4. Microbiology of Marine Food Products. Ward, D. R. and C. Hackney. 1991. Van Nostrand Reinhold, New York. 438 pp.
5. Introduction to Microbiology, Walter, McBee Temple.
6. Hand Book of Microbiology, P. S. Bisen and KavitaBerma.
7. Microbiology In "Fisheries Studies": Part-I. Mansur, M. A. 2010. Botomul (Publisher), Dhaka. 234-312 pp.
8. Practical food microbiology. Edited by Diane Roberts, Melody Greenwood.3rd ed. 2003.

0831-1106: Biochemistry

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete 4-year B. Sc. in Fisheries (Honours) degree. The course covers the basic knowledge of carbohydrate, protein, lipid and nucleic acids in life systems. The course is designed to strengthen knowledge in details of the acid, base, buffer and cellular functions. This course can also teach them in details of carbohydrate, proteins, lipid and nucleic acids with their properties, sources, function, structures, reactions etc. The objectives are to provide students with the knowledge of carbohydrate, protein, lipid and nucleic acids in life system; and also to provide students with the knowledge of metabolism of carbohydrate, protein, lipid in life system and Enzymes, Vitamins, Hormone and overall nutrition in life system.

Expected outcomes:

At/by the end of the course, the students will be able to-i) Understand the chemical basis of life; ii) Know details of carbohydrates, protein, lipids and nucleic acids in life system. At/by the end of the course, the students will be able to understand the metabolism of major nutrients and role of enzyme, vitamin, and hormones as well. Knowledge gained from this course will be useful for studying other courses like-Fish processing, fish food chemistry, fish nutrition etc.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Define protein, amino acids, protein denaturation and essential & non-essential amino acids: outlines the classification of protein and amino acids; explain the physico-chemical properties of proteins and amino acids; illustrate the structures protein and amino acids. Explain about protein metabolism.	5
CLO2	Outlines of the types and describes the structure, properties & functions of lipid, fatty acids, essential fatty acids, triacylglycerol, phospholipids, glycolipids, lipoprotein and steroids; illustrate the chemical reactions of fatty acids; apply the purity tests of fats and oil.	4
CLO3	Describe the composition, sources, function, physical and chemical properties of carbohydrate; illustrated the structure and describe sources and properties of some important disaccharides, trisaccharides and polysaccharides. Explain about carbohydrate metabolism.	5
CLO4	Define nucleic acid; outlines the classification of nucleic acid; describe the occurrence, composition and functions of nucleic acids; illustrate and describe the structure and properties of DNA and RNA.	4

CLOs	Course Learning Outcomes	Lectures
CLO5	Describe enzymes with emphasis on classification, nomenclature and chemical nature	3
CLO6	Describe about vitamins with emphasis on their classification, sources, chemical properties, biochemical role and dietary vitamin deficiency in fish.	3

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching strategy	Assessment Strategy
CLO1	**Proteins:** Definition, classification, physico-chemical properties of proteins, amino acids as monomeric unit, their physico-chemical properties and structures, naturally occurring peptides, reaction used for sequence determination, structural organization of proteins, essential and non-essential amino acids; protein denaturation, fish proteins and its nature. Protein Metabolism: General fate of dietary amino acids, deamination, transamination, decarboxylation, urea cycle, classification of organisms on the basis of nitrogenous end products. Fixation of nitrogen by aquatic plants.	Lectures followed by discussion Participatory question-answer Online resources	**Total (100)** Attendance (10) In course Examination/ Tutorial/Quiz/ Class Test (20) Final Examination (70)
CLO2	**Lipids:** Definition, classification, function of lipid; definition, types, nomenclature, chemical reactions of fatty acids; definition, structure and function of essential fatty acids; definition, structure and properties of triacylglycerol; purity tests of fats and oil; definition, types, structure and function of phospholipids; glycolipids, lipoprotein and steroids. Lipid	Lectures followed by discussion Participatory question-answer Online resources	

CLOs	Course Contents	Teaching strategy	Assessment Strategy
	Metabolism: β and alpha-oxidation, propionyl CoA and ketone bodies metabolism.		
CLO3	**Carbohydrates:** Definition, composition, sources, function, classification, physical and chemical properties of carbohydrate; structural aspects and reactions of monosaccharides; structure, sources and properties of disaccharides, trisaccharides and polysaccharides**.** Major pathways of carbohydrate metabolism, glycolysis, TCA cycle, hexose monophosphate pathway, gluconeogenesis.	Lectures followed by discussion Participatory question-answer Online resources	
CLO4	**Nucleic acid:** Definition, classification, occurrence, composition and biological function, structures and property of DNA, DNA as genetic material, types, functions and structure of RNA.		
CLO5	**Enzymes:** Definition, classification, nomenclature, chemical nature and property of enzymes; concepts of enzyme cofactors, factors affecting enzymatic activity; allosteric enzyme, feedback inhibition, role of enzymes in deterioration of fish and fishery products.		
CLO6	**Vitamins:** Definition, classification, sources, chemical properties and biochemical role, dietary vitamin deficiency in human body.	Lectures followed by discussion Participatory question-answer Video	

Recommended literature:

1. Outlines of Biochemistry, 5th edn., E. E. Con and P. K. Stumpf (1987), John Wiley and Sons, New York.
2. Text Book of Biochemistry, 2nd edn., A. I. Lehninger (1976), Worth Publi., New York.
3. Practical Biochemistry for Students, P. K. Talwar and A. G. Jhingran (1991), Laypec Brothers, New Delhi.
4. Biochemistry Laboratory Manual, F. M. Strong (1965), William C. Brown Co., Iowa.
5. Biochemistry, D. Voet and J. Voet (1990), John Wiley and Sons, New York.
6. Principles of Biochemistry, 6th edn., A. White, P. Handler and E. L. Smith (1976), McGraw Hill Co., New York.
7. Textbook of Biochemistry by Dr. K. Ram Babu, 2007. Virender Kumar Arya. AIT. B. S. Publishers, India.
8. A Textbook of Biochemistry by A. V. S. S. Rama Rao (1997). UBS Publishers Pvt. Ltd. Co. New Delhi.

Practical Courses

0831-1111: Practical on Introduction to Fisheries Resources

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcome	Lectures
CLO1	Identify the taxonomic position of fishes, shellfishes and other fisheries specimen	4
CLO2	Collect fisheries specimen from local fish market or local water bodies in fresh condition.	2
CLO3	Survey of fishes, shellfishes and other fisheries items in local fish markets as well as aquarium fish shop.	3
CLO4	Study commercially important groups of SIS, threatened and exotic species and other fisheries items, of a selected water bodies and fisheries hotspot.	3
CLO5	Visit local fisheries institution and cooperatives (GO and NGO) to know about their activities in fisheries sector.	2
CLO5	Collect and compute data from fisheries resource survey system (FRSS)	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Study of identification and taxonomic position (PCOFG) of fishes, shellfishes and other fisheries specimen	- Lectures - Problem solve	**Full marks:100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Fisheries specimen collection from local fish market or local water bodies in fresh condition.	- Lectures - Problem solve	
CLO3	Survey of fishes, shellfishes and other fisheries items in local fish markets as well as aquarium fish shop.	- Lectures - Problem solve	
CLO4	Study of commercially important groups of SIS, threatened and exotic species and other	- Lectures	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
	fisheries items, fisheries equipment of a selected water bodies as well as fisheries hotspot.	- Problem solve	
CLO5	Visit to local fisheries institution and cooperatives (GO and NGO) to know about their activities in fisheries sector.	- Lectures - Problem solve	
CLO6	Data collection and computation from fisheries resource survey system (FRSS)	- Lectures - Problem solve	

0831-1112: Practical on General Ichthyology - I

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Identify body form, appendages, openings, scales of different fish groups.	2
CLO2	Understand and demonstrate the blood circulatory system of different fish groups.	4
CLO3	Understand and demonstrate the urinogenital system of fishes.	2
CLO4	Understand and demonstrate the respiratory organs of fishes.	2
CLO5	Understand and demonstrate Weberian ossicle, ear stone etc.	1

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Study of body form, appendages, openings, scales of cartilaginous and bony fishes.	-Lecture -Demonstration	**Full marks: 100** Attendance :10 Class record/Report:30
CLO2	Dissection and study of the blood circulatory system of cartilaginous and	-Dissection	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
	bony fishes.	-Demonstration	Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc)
CLO3	Dissection and study of the urinogenital system of fishes.	-Dissection -Demonstration	
CLO4	Dissection and study of the respiratory organs of fishes.	-Dissection -Demonstration	
CLO5	Dissection and study of weberianossicle, ear stone etc.	-Dissection -Demonstration	

0831-1113: Practical on Fisheries Zoology

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Draw diagram and identify of museum specimen including identifying characteristics and taxonomic position (PCOFGS) of commercially important invertebrate species special reference to Bangladesh fisheries.	3
CLO2	Draw diagram and identify morphological features of selected crustaceans and mollusks found in Bangladesh.	3
CLO3	Show, draw diagram, gives an example and explain Polarity and Cephalization, Planes, Symmetry, Metamerisis, Tagmatization of invertebrates and vertebrates.	3
CLO4	Distinguish different fisheries vertebrates with special reference to Bangladesh fisheries.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	●	X	X	X
CLO2	X	●	X	X	X
CLO3	X	●	X	X	X
CLO4	X	●	X	X	X

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Study of museum specimen including identifying characteristics and taxonomic position (PCOFGS) of commercially important invertebrate species special reference to Bangladesh fisheries.	- Observation - Characteristics analysis - Drawing	**Full marks: 100** Attendance :10 Class record/Report:20 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Morphological study of selected crustaceans and mollusks found in Bangladesh.	- Demonstration - Characteristics analysis - Drawing	
CLO3	Polarity and Cephalization, Planes, Symmetry, Metamerisis, Tagmatization of invertebrates and vertebrates.	- Observation - Demonstration - Drawing	
CLO4	Profile study of fisheries vertebrates special reference to Bangladesh fisheries.	-Documentary film showing	

0831-1114: Practical on Freshwater Ecology

Credit: 1
Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Discuss about different physical, chemical and biological factors in lentic habitat	3
CLO2	Measure and describe about different physical, chemical and biological factors in lotic habitat	3
CLO3	Explain different components, factors, modifications of floodplain ecosystem.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	**Study of pond as lentic ecosystem:** Physical, chemical and biological factors (community composition and ecological classification).	- Lectures - Laboratory analysis	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	**Field visit on river as a lotic ecosystem:** Physical, chemical and biological factors (community composition and ecological classification).	- Lectures - Field visit	
CLO3	**Field visit on floodplain ecosystem:** Different components, factors, modifications.	- Lectures - Field visit	

0831-1115: Practical on General Microbiology

Credit: 1
Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe types, principles and operation of microscopes.	2
CLO2	Suggest safety issues and guide lines of a microbiology laboratory. Describe important terminology for exercises in the microbiological practical classroom.	2
CLO3	Accomplish different sterilization techniques.	2
CLO4	Identify different microorganisms.	2
CLO5	Describe types and ingredients of culture media; and prepare different culture media.	2
CLO6	Culture microorganisms: Broth, pour plate, spread plate, streak plate, slant, stab, swaband shake culture.	4

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Study of microscopes: Types, principles and operation.	-Lecture -Demonstration	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	General suggestions, safety and guide line of a microbiology laboratory. Important terminology for exercises in the microbiological practical classroom	-Lecture -Demonstration	
CLO3	Study of different sterilization techniques.	-Lecture -Demonstration	
CLO4	Identify different microorganisms.	-Lecture -Demonstration	
CLO5	Study of culture media: Types, ingredients and preparation.	-Lecture -Demonstration	
CLO6	Culture of microorganisms: Broth, pour plate, spread plate, streak plate, slant, stab, swaband shake culture.	-Lecture -Demonstration	

0831-1116: Practical on Biochemistry

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe and prepare different types of solution used in chemistry	2
CLO2	Prepare standard solution and standardization of HCl	1
CLO3	Prepare buffer solution; determine its pH	1

CLOs	Course Learning Outcomes	Lectures
CLO4	Estimate of acetic acid from vinegar	1
CLO5	Demonstrate the tests for carbohydrates; estimate the reducing sugar; prepare starch solution and determine its content	3
CLO6	Demonstrate the proteins colour tests; determine the isoelectric pH of protein; estimate the protein by Kjeldahl method.	3

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Study of different types of solution used in chemistry.	- Lectures - Laboratory - Problem solve	**Full marks: 100** Attendance :10 Class record/Record:30 Practical:60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Preparation of standard solution and standardization of HCl.	- Lectures - Laboratory Experiment	
CLO3	Preparation of buffer solution and determination of its pH	- Lectures - Laboratory Experiment	
CLO4	Estimation of acetic acid from vinegar	- Lectures - Laboratory Experiment	
CLO5	Tests for carbohydrates, estimation of reducing sugar, preparation of starch and its determination.	- Lectures - Laboratory Experiment	
CLO6	Proteins colour tests, determination of isoelectric pH of protein, estimation of protein by Kjeldhal method.	- Lectures - Laboratory Experiment	

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Theoretical Courses

0831-1201: Developmental Biology

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a theoretical course on developmental biology of fishes and other fisheries items and prerequisite to complete the 4-years B.Sc. in Fisheries (Honours) degree. The course covers gametogenesis, fertilization, principle of embryonic development, developmental biology of fishes and shellfishes and factors affecting the development.

Learning Outcomes:

At the end of the course, the students will be able to- i) know the mechanisms of gametogenesis, fertilization and embryonic development of fish and shellfish ii) know the developmental biology of some important fish and shellfishes iii) realize the factors affecting the developmental biology of fish and shellfishes.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Recall and explain the mechanism of fertilization, Reproduction and Gametogenesis of fish and shell fish.	4
CLO2	Discuss the embryonic development of fish and shellfish.	6
CLO3	Explain and the factors affecting the development of fish and shellfish.	5
CLO4	Discuss and compare the food and feeding habits of fish and shellfish at different life stages.	2
CLO5	Understand and distinguished the different stages of maturation, sexual dimorphism of fish and shell fish	5
CLO6	Estimate the fecundity and gonadal length index (G.L.I.) and gonado-sometic index (G.S.I.) of fishes.	6

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Background, pioneer, objective, expected outcome, importance and scope of the course.	Lectures followed by discussion Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO1	**Gametogenesis:** Spermatogenesis and oogenesis, structure of sperm and ovum, egg types.	Lectures followed by discussion Participatory question-answer	
CLO1	**Fertilization: T**ypes, events, polyspermy and monospermy, chemistry, significance.	Lectures followed by discussion Participatory question-answer Online resources	
CLO2	**Developmental stages of fishes::** zygote, cleavage patterns, blastulation, gastrulation, organogenesis and coelom formation, placentation	Lectures followed by discussion Participatory question-answer Online resources	
CLO2	**Developmental biology of fishes:** Embryonic development, fry, juveniles, adults.	Lectures followed by discussion Participatory question-answer Online resources	
CLO2	**Developmental Biology of shellfishes:** Commercially important crustacean and molluscs species.	Lectures followed by discussion Participatory question-answer	
CLO3	**Factors affecting the development** of fin fishes and shellfishes.	Lectures followed by discussion Participatory question-answer	
CLO4	**Food and feeding habits** of different life	Lectures followed by	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
	stages of fishes and shellfishes.	discussion Participatory question-answer Online resources	
CLO5	Sexual dimorphism and maturation stages.	Lectures followed by discussion Participatory question-answer Online resources	
CLO6	Fecundity, gonadal length index and gonado-somatic index.	Lectures followed by discussion Participatory question-answer Online resources	

Recommended literature:

1. The Biology of the Mollusca, R. D. Purchon (1978), Pergamon Press, Sydney.
2. Reproductive Biology of Invertebrates: Mollusca. Vol. I-IV (1992), Edited by: K. G. Adiyodi and R. G. Adiyidi.
3. Snail, Flukes and Man, Edited by: S. Jairajpuri (1989), Zoological Survey of India.
4. Seashells, S. Peter Dance (1982), Hamlyn Paperbacks.
5. A Functional Biology of Marine Gastropods, R. G. Hughes (1986), Croom Helm.
6. Handbook Freshwater Molluscs of India, N. V. SubbaRao (1989), Zoological Survey of India, Calcutta, Government of India.
7. Freshwater Ostracoda, Z. S. Bronshtein (1988), Oxonian Press Ltd., New Delhi, Calcutta.
8. Crabs and Crab Fisheries of Sundarban, N. C. Nandi and S. K. Pramanik (1994), Hindustan Publishing Corporation, Delhi-110007.
9. Growth and Ecology of Fish Populations, A. H. Weatherly (1972), Academic Press, London, New York.

0831-1202: General Ichthyology - II

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course to complete 4-year B. Sc. Fisheries (Honours) degree. The course covers the morphology of skeletal, muscular, digestive, endocrine and nervous system in fish body. The contents mainly focus the proper feature on basic structure and function of fish body. The course also provides basic concepts on the receptor organs and adaptive radiation in fishes with

reference to special organs like poison glands, light organs, electric organs etc.The course will strengthen students' knowledge on fish morphology which is prerequisite to understand fisheries science.

Learning Outcomes:

At the end of the course, the students will be able to- i) know the basic structure and function of major organ systems of fish; ii) explain the structure and function of some special organs of fish; iii) apply acquired knowledge in all aspects of studying fishery science.

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

CLOs	**Course Learning Outcomes**	**Lectures**
CLO1	Explain and distinguish development of bone and variation in their structural modification in formation of skeletal system of fish.	6
CLO2	Explain the structure and function of musculature; and distinguish their association with the skeletal system.	4
CLO3	Differentiate structure, function and variation in digestive system in different fish groups and associated glands related to digestion.	4
CLO4	Explain the structure and function of endocrine glands, evaluate their mode of action and hormone secretion.	4
CLO5	Explain the structure and function of nervous system with mode of action.	5
CLO6	Explain the structure and mode of action of different receptor organs; and understand the role of special organs in adaption.	5

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	**PLOs**				
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**
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

Lesson plan

CLOs	**Course Contents**	**Teaching Strategy**	**Assessment Strategy**
CLO1	**Skeletal System:** cartilage and bone; exoskeleton and endoskeleton; membranous skeleton; axial skeleton; appendicular skeleton; visceral skeleton; origin of limbs and girdles.	-Lecture followed by discussion -Power point presentation	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20
CLO2	**Muscular System:** classification and muscle terminologies–skeletal muscles in	-Lectures followed by	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
	head, trunk and tail, branchial musculature, eye muscles, median and paired fin musculatures, smooth muscles and cardiac muscles.	discussion -Participatory question-answer -Power point presentation	Final Examination: 70
CLO3	**Digestive system:** definition, alimentary tracts and modification and digestive glands.	-Lectures followed by discussion -Participatory question-answer -Power point presentation -Online resources	
CLO4	**Endocrine system:** Type, origin, hormone secretion and action.	-Lectures followed by discussion -Participatory question-answer -Power point presentation -Online resources	
CLO5	**Nervous system:** classification, brain and spinal cord, cranial and spinal nerves and autonomic nervous system.	-Lectures followed by discussion -Participatory question-answer -Power point presentation -Online resources	
CLO6	**Special organs:** receptors (classification, structure and function); poison glands, light organs, electric organs.	-Lectures followed by discussion -Participatory question-answer -Power point presentation -Online resources	

Recommended literature:

1. Ichthyology, K. F. Lagler, J. E. Bardach, R. R. Miller and D. R. M. Passino (1977). John Wiley and Sons. New York.
2. Freshwater Fishery Biology. K. F. Lagler (1952), IOWA Press Inc. USA.
3. Reading in Ichthyology, M. S. Love and G. M. Cailliet (eds) (1979), Prentice –Hall of India Pvt. Ltd., New Delhi.
4. The Life of Fishes, N. B. Marshall (1965), Weidenfeid and Nicolson, London.
5. A Text Book of Fish Biology and Fisheries, Q. Bone and R. H. Moore (2008), Taylor & Francis Group, UK.
6. A Text Book of Fish Biology and Fisheries, S. S. Khanna and H. R. Singh (2006), Narendra Publishing House, Delhi-110006, India.
7. Anatomy and Physiology of Fishes, S. Kumar and M. Tembhre (1998), Vikas Publishing House Pvt. Ltd., India.

8. The Vertebrate Body, A. S. Romer (1949), W. B. Saunders Co., Philadelphia.
9. A Laboratory manual of Comparative anatomy of the Chordates, A. H. Stockard (1949), Edward Bros., Michigan.
10. The Ways of Fishes, L. P. Schultz and E. M. Stern (1949), D. Van Nostrand Co. Inc., New York.
11. Studies on the Structures and development of vertebrate, Vols. I and II, E. S. Goodrish (1958), Dover Publ., New York.
12. An Introduction to the studies of Fishes, A. C. L. G. (1963), Today and Tomorrows Book Agency, New Delhi.
13. Comparative Vertebrate Anatomy, L. H. Hyman (1961), The Chicago Univ. Press, USA.
14. Function and gross Morphology in Fish, Y. G. Aleev (ed) (1969), Keter Press, Jerusalem.
15. Ichthyology, L. P. Poznanin (1977), Amerind Publishing Co. Pvt. Ltd., New Delhi, Bombay, Calcutta, New York.
16. Air-breathing Fishes of India, J. S. DattaMunshi and G. M. Hughes (1992), Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, Bombay, Calcutta.

0831-1203: Fundamentals of Aquaculture

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete 4-year B. Sc. in Fisheries (Honours) degree. The course covers different aspects of aquaculture such as principles, systems and management of aquaculture. The course is designed to strengthen the student's existing knowledge on management practices in pond aquaculture and transportation practice of live fry, fingerlings and adult fishes. This course can also teach them about common problems found in aquaculture management.

Learning Outcomes:

At the end of the course, the students will be able to: i) explain principles needed for aquaculture operation; ii) identify and differentiate the characteristics of the aquaculture systems; iii) recognize management for aquaculture operation including seed/adult fish transportation.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe general aspects of aquaculture	1
CLO2	Conceptualize various culture systems.	3
CLO3	Know about various culture techniques.	2
CLO4	Describe and demonstrate management practices in pond aquaculture.	5
CLO5	Describe and demonstrate transportation practice of live fry, fingerlings and adult fishes	4
CLO6	Identify and solve common problems found in aquaculture management	4

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	**Introduction:** definition, potentials, scope, problems, risks and threats of aquaculture. Addressing aquaculture to meet the need of National Fisheries Policy and development goals (MDG, SDG etc.)	-Lectures followed by discussion -Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	**Principles and concepts:** General principles of aquaculture; concept of monoculture, polyculture, composite culture; hatchery, nursery and grow out operation.	Lectures followed by discussion -Participatory question-answer	
CLO3	**System and advancements in aquaculture:** Extensive, semi-intensive and intensive culture; organic aquaculture, weed based aquaculture, carp fattening, region specific aquaculture,Biofloc aquaculture, RAS, sustainable aquaculture.	-Lectures followed by discussion -Participatory question-answer	
CLO4	**Management practices in pond aquaculture** (pre-stocking, stocking and post-stocking measures emphasizing pond drying, pond liming, removal of aquatic weeds, removal of predatory and unwanted fishes/animals, pond fertilization, selection of species, supplementary feeding, sampling, partial harvesting and restocking, final harvest and marketing).	-Lectures followed by discussion -Participatory question-answer	
CLO5	**Transportation of live fry and fingerlings and adult fishes:** Equipment, water quality, handling, loading and stocking, shipping, use of anesthetics and antiseptics during transportation.	Lectures followed by discussion -Participatory question-answer	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO6	**Common problems** found in aquaculture management (water quality, disease etc.) and their solution.	Lectures followed by discussion -Participatory question-answer	

Recommended literature:

1. Training Manual for Extension Personnel on Low-cost Environment Friendly Sustainable Aquaculture Practices. Grover, J. H.; M. A. Islam; W. A. Shah, M. A. H. Rana and H. A. Chowdhury (2000). ICLARM- The World Fish Centre, Dhaka, Bangladesh.
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. Muir, J. F. and Roberts, R. J. (Eds.) Recent Advances in Aquaculture, Vol. I, II, III and IV, Croom Helm, London.
6. Pillay, T. V. R. 1994. Aquaculture Development: Progress and Prospect. Fishing News Books Black well Scientific Publications Ltd. Oxford.

0831-1204: Coastal and Marine Ecology

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete 4-year B. Sc. in Fisheries (Honours) degree. The course covers the estuarine, mangrove, coastal and marine ecosystems. The course is designed to strengthen the student's existing knowledge on coastal and marine environment and interaction among the living and non-living components of the ecosystems with their limiting factors and driving forces. This course can also teach them about different ecosystem of coastal and marine habitat and different environmental factors which control these habitats. A number of further topics, like the, intertidal rocky shore, sandy beach, coral reef, marine community, population ecology will be also focused in the course.

Expected Outcomes:

After completion of this course, the students will learn about different ecosystem of coastal and marine habitat and different environmental factors which control these ecosystems.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe basic concept on the components of coastal and marine ecosystems; ecological cycle of the sea.	2
CLO2	Explain estuarine ecosystem in terms of characteristics, classification, limiting factors, production potential of estuary. Exploit mangrove ecosystem (types of mangrove; limiting factors; organisms; economic value; causes of mangrove destruction)	5
CLO3	Discuss coastal ecosystem (types, limiting factors and driving forces, human impact and threats)	2
CLO4	Exploits marine habitat (classification of marine environment; coral reef; threaten factors in coral reef and their management approach).	3
CLO5	Explain marine ecosystem with their types, limiting factors and driving forces. Discuss marine community with their classification. Explain intertidal ecosystem (rocky shores; sandy beaches; coastal upwelling)	6
CLO6	Explain population ecology (natality; mortality; age distribution; growth form; types of interaction between two species)	3

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Ecological dynamics : a) Basic concept on the components of marine ecosystem, habitat and ecological niche, trophic level, food chain and food web, trophic structure and ecological pyramids, Production, decomposition and transformation of organic matter. b) Ecological cycle in the sea, major ecological feature of the sea.	- Lectures followed by discussion - Participatory question-answer -	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO2	Estuarine ecosystem: Definition, characteristics of estuary, classification of estuaries; Limiting Factors, Ecological classifications of estuarine organisms, Natural productivity and food production potential of Estuaries, Estuarine Food Web, Values of Estuaries, Human Impacts and Threats. Mangrove ecosystem: Definition, Types of mangrove, Limiting factors and driving forces, Organisms associated to mangrove, Economic value of mangrove, Mangrove forest of Bangladesh, Cause and effects of mangrove destruction.	- Lectures followed by discussion - Participatory question-answer - Video demonstration - Online resources	
CLO3	Coastal ecosystems: Definitions, Types, Limiting Factors and Driving Forces, Coastal/Brackish water Organisms, Inter-tidal Niche, Importance of Coastal Environment, Human Impacts and Threats, Coastal Areas of Bangladesh.	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO4	Marine habitats: Marine environment, classification of marine environment; coral reefs- definition, types of coral reef, fauna of coral reef, factors affect coral reformation, threaten factors of coral reefs, approaches of reef conservation and management.	- Lectures followed by discussion - Participatory question-answer - Online resources - Video demonstration	
CLO5	Marine ecosystem: Definition, Types of marine ecosystem, limiting factors and driving forces of marine ecosystem, ecological classification of marine organisms. Intertidal ecosystem: Intertidal rocky shores, Sub-tidal rocky shores, sandy beaches, and coastal upwelling systems. Marine communities: Plant, animal and microorganism communities of abyssal, mid-depth pelagic, upper oceanic, inshore, pelagic, sublittoral, bottoms, sandy, rocky and muddy shores.	- Lectures followed by discussion - Participatory question-answer	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO6	Population ecology: Concepts of population; population density rates natality; mortality, age distribution, biotic potential and environmental resistance, growth form, population dispersal and structure, Types of interaction between two species.	- Lectures followed by discussion - Participatory question-answer	

Recommended literature:

1. Mann, K.H. Ecology of Coastal Waters. Blackwell Science Inc., USA, 2000.
2. Levinton, J. *Marine Biology. Function, Biodiversity, Ecology*
3. Chapman, V.J. - Coastal ecosystems
4. Colinvaux - Ecology
5. Day, J.W. et. al - Estuarine ecology - A wileyintersince publication. - John wiley and sons. New York, 1989.
6. Leivinton, J.S. - Marine Ecology- John wiley and sons Inc. New York. 1966.
7. Longhurst, A.R. - Analysis of marine ecosystems- Academic press, London, 1981.
8. Mac Arthur, R.I. Geographical ecology: Patterns in the distribution of species
9. Odum, E.P. Fundamental of ecology. Philadelphia, sunders college publishing house, New delhi.

0831-1205: Physico-chemical Limnology

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course to complete 4-year B. Sc. Fisheries (Honours) degree. The course focuses on the physical and chemical parameters of inland waters including their importance and scope. Content of the course covers physical features of inland water bodies and their formation. The course specially focuses on the physical and chemical properties of water that considered as essential components to learn about aquatic ecosystem. The course also deals with the soil properties, along with soil-water interaction responsible for nutrients transfer. The course will strengthen students' acquired knowledge in managing proper aquaculture practice.

Learning Outcomes:

At the end of the course, the students will be able to- i) analyze the suitability of physico-chemical properties of waterbody for aquatic organism; ii) relate the role of soil-water interaction in aquatic

primary production; iii) apply acquired knowledge in managing proper aquaculture practice.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe the history behind limnology and explain its importance with scope.	2
CLO2	Analyze the characters of inland waterbodies and their formation; and summarize the salient features *viz.* types, origin, sources of water of the rivers of Bangladesh.	6
CLO3	Analyze the physical and chemical properties of inland waterbodies.	6
CLO4	Distinguish the physico-chemical parameters of pure water.	4
CLO5	Analyze the physico-chemical characters of soil and mechanism of nutrient transfer.	6
CLO6	Relate soil-water interaction in determining the productivity of aquatic environment.	4

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Introduction, definition, importance, history and scope of Limnology.	-Lecture -Power point presentation	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	**Characteristics and formation of inland waters**: pond, lakes, swamps and marshes, streams, estuaries, rivers (definition, types, origin, sources of water), rivers of the world.	-Lectures followed by discussion -Participatory question-answer -Power point presentation	
CLO3	**The physical and chemical characteristics of inland water:** solar radiation and natural waters (light, colour, turbidity, transparency, water current and movement), heat of	-Lectures followed by discussion -Participatory question-answer -Power point presentation	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
	natural waters (temperature, thermal classification of lakes, heat budget and lake stability, holomixis and meromixis); Dissolved gases in inland waters (dissolved oxygen, CO_2 and other gases). Dissolved solids in natural waters (nitrogenous compounds, phosphorous, calcium and magnesium, sodium and potassium, iron, silica, trace elements and salinity). Role of nutrients in primary production, pH.	-Online resources	
CLO4	**The nature of water:** The water molecule, physical and chemical characteristics of pure water.	-Lectures followed by discussion -Participatory question-answer -Power point presentation -Online resources	
CLO5	**Soil:** Definition, soil in the aquatic environment, soil components-mineral matter, air and water; characteristics of bottom soils, soil pH, ion exchange, base saturation, organic matter, C/N ratio, essential nutrients, electrochemical exchanges of elements, soil fertility evaluation.	-Lectures followed by discussion -Participatory question-answer -Power point presentation -Online resources	
CLO6	**Soil water interaction** and their role in determining the productivity of aquatic environment.	Lectures followed by discussion -Participatory question-answer	

Recommended literature:

1. Text Book of Limnology, G. A. Cole (1979), The Mosby Co., London.
2. Limnology, C. R. Goldman and A. J. Horne (1983), McGraw Hill Book Co.
3. A - Treatise on Limnology vol. I and II, G. E. Hutchinson (1975), John Wiley and Sons, NY.
4. Limnology, P. S. Welch (1952), McGraw Hill Book Co.
5. Limnology, R. G. Wetzel (1983), Saunders College Publ., Philadelphia, USA.
6. A Handbook of Limnology, Lind.
7. Limnological Analysis (3rd edn), Robert G. Wetzel and Gene E. Likens (2000), Springer.
8. Fundamentals of Limnology, Franz Ruttner (1970), Walter de Gruyter& Co., Berlin.

0831-1206: Fisheries Microbiology

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete 4-year B. Sc. in Fisheries (Honours) degree. The course covers the aquatic microorganism, role of microorganism on contamination and spoilage, effects of processing on microorganisms and foodborne illness. The course is designed to strengthen the student's existing knowledge on contamination and spoilage of fish and fishery products and their decontamination process. This course can also teach them in details of bacterial food borne illness. This course also focuses the factors affecting the microbial growth and spoilage and sanitation in fish processing activities.

Learning Outcomes:

At/by the end of the course, the students will be able to know about spoilage of foods and pathogenic bacteria and decontamination of bacteria by processing methods. Knowledge gained from this course will be useful for studying other courses like- Fish processing, Quality control, Fish pathology etc.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Define and describe the contamination and spoilage of fish and sea food; outlines of microorganisms of cold, temperate and tropical regions, sources of post-harvest contamination; interpret the causes of spoilage, factors influencing the kind and rate of spoilage; outlines the chemical changes caused by microorganisms, spoilage of frozen fish, canned fish, cured fish, fermented fish and surimi based products.	4
CLO2	Define and describe the microbial food borne illness such as - Botulism, Staphylococcal intoxication, Salmonellosis, E. coli infection in terms of causative agent, mechanisms, symptoms, sources, precautions, and treatments	4
CLO3	Draw and describe the growth curve of yeast, mold and bacteria; explain the factors affecting microbial growth such as temperature, water activity, pH, redox-potential, nutrients, inhibitors and microbial interactions.	4
CLO4	Define, discuss and uses of antimicrobial agents: physical (low temperature, heat, desiccation, irradiation, filtration) and chemical (antiseptics and disinfectants, chemical sterilants, antibiotic); interpret the mode of action of antimicrobial agents	4
CLO5	Explain the effects of different preservation & processing methods on microorganisms such as low temperature, high temperature, curing and other methods	3

CLOs	Course Learning Outcomes	Lectures
CLO6	Define and explain the quality, quality control, quality assurance, quality inspection, and quality verification; define HACCP; outlines the principles and application of HACCP in fish processing industry.	3

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Contamination and spoilage of fish and sea food: Definition of contamination, microorganisms of cold, temperate and tropical regions, sources of post-harvest contamination; definition and causes of spoilage, factors influencing the kind and rate of spoilage, chemical changes caused by microorganisms; spoilage of frozen fish, canned fish, cured fish, fermented fish and surimi based products.	- Lectures followed by discussion - Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	Microbial food borne illness: Food poisoning, bacterial food intoxication and infection-causative agent, mechanisms, precautions; Botulism, Staphylococcal intoxication, Salmonellosis, E. coli infection.	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO3	Microbial growth in food: Growth curve of yeast, mold and bacteria; factors affecting microbial growth-Temperature, water activity, pH, redox-potential, nutrients, inhibitors and microbial interactions.	- Lectures followed by discussion - Participatory question-answer - Online resources	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO4	Antimicrobial agents: Definition, physical (low temperature, heat, desiccation, irradiation, filtration) and chemical (antiseptics and disinfectants, chemical sterilants,antibiotic) antimicrobial agent, definition, types, characteristics, mode of action and uses.	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO5	Effect of preservation on microorganisms: Effect of low temperature and high temperature, effect of curing and other preservation and processing methods.	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO6	Food safety and quality control: Microbiological quality of fishery products; quality control and quality assurance; microbiological standard and sanitation in fish processing industry; definition, principles and application of HACCP in fish processing industry.	- Lectures followed by discussion - Participatory question-answer - Online resources	

Recommended literature:

1. Microbiology - An introduction to protests, J. S. POINDEXTER
2. Food Microbiology. 3rd Edition, Frazier W. C. and D. C. Westhoff. 1990. McGraw Hill Book Co., New York, London. 502 pp.
3. A Text Book of Microbiology, Burrows.
4. Microbiology of Marine Food Products. Ward, D. R. and C. Hackney. 1991. Van Nostrand Reinhold, New York. 438 pp.
5. Introduction to Microbiology, Walter, McBee Temple.
6. Hand Book of Microbiology, P. S. Bisen and KavitaBerma.
7. Microbiology In"Fisheries Studies": Part-I. Mansur, M. A. 2010. Botomul (Publisher), Dhaka. 234-312 pp.
8. Practical food microbiology. (Ed) Diane Roberts, Melody Greenwood. 3rd ed. 2003.

Practical Courses

0831-1211: Practical on Developmental Biology

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Identify and characterize fish and shellfish.	3
CLO2	Identify and characterize different post-larvae and juvenile stages of prawn, shrimp, crab, fish etc..	3
CLO3	Reveal sexual dimorphism of fish and shellfishes.	3
CLO4	Identify and characterize maturation stages of gonads in different size of fishes.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	●	X	X
CLO2	X	X	●	X	X
CLO3	X	X	●	X	X
CLO4	X	X	●	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Identification of fish and shellfish larvae.	-Lecture -Demonstration	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Identification of post-larvae, fry and juvenile stages of prawn, shrimp, crab, fish etc.	-Lecture -Demonstration	
CLO3	Study of sexual dimorphism of fish and shellfishes.	-Lecture -Dissection -Demonstration	
CLO4	Study of maturation stages of gonads in different size of fishes.	-Lecture -Dissection -Demonstration	

0831-1212: Practical on General Ichthyology - II

Credit: 1
Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	**Course Learning Outcomes**	**Lectures**
CLO1	Understand and demonstrate the skeleton of different fish groups.	3
CLO2	Understand and demonstrate Weberianossicle, ear stone etc.	2
CLO3	Understand and demonstrate the digestive tracts of different fish groups.	3
CLO4	Understand and demonstrate the cranial nerves of cartilaginous and bony fishes.	4
CLO5	Understand and demonstrate the pituitary gland poison gland etc. of fishes.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	**PLOs**				
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**
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

Lesson plan

CLOs	**Course Contents**	**Teaching Strategy**	**Assessment Strategy**
CLO1	Comparative study of skeleton of different fish groups.	-Lecture -Demonstration	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Dissection and study of Weberian ossicles, ear stone.	-Dissection -Demonstration	
CLO3	Dissection and study of digestive tracts of different fish groups.	-Dissection -Demonstration	
CLO4	Dissection and study of the cranial nerves of cartilaginous and bony fishes.	-Dissection -Demonstration	
CLO5	Dissection and study of the pituitary gland poison gland etc.	-Dissection -Demonstration	

0831-1213: Practical on Fundamentals of Aquaculture

Credit: 1
Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Identify and characterize aquaculture species.	2
CLO2	Identify and characterize aquatic weeds.	1
CLO3	Identify and characterize fertilizers, fish feeds, feed ingredients and chemicals used in aquaculture.	3
CLO4	Calculate input amount in pond. And Demonstrate liming, fertilization, stocking, feeding and seed/fish transportation.	3
CLO5	Monitor water quality parameters in aquaculture pond.	1
CLO6	Study sample cases on aquaculture in pond.	1

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Identification of aquaculture species.	-Lecture -Demonstration	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Identification of aquatic weeds.	-Lecture -Demonstration	
CLO3	Identification of fertilizers, fish feeds, feed ingredients and chemicals used in aquaculture.	-Lecture -Demonstration	
CLO4	Calculation for input application in pond. Method demonstration on liming, fertilization, stocking, feeding and seed/fish transportation.	-Lecture -Demonstration -Field observation	
CLO5	Water quality monitoring in	-Lecture	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
	aquaculture pond.	-Field observation	
CLO6	Case study on aquaculture in pond.	-Lecture -Demonstration	

0831-1214: Practical on Coastal and Marine Ecology

Credit: 1
Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe about the instruments required in the coastal and marine field study.	1
CLO2	Understand the importance of field visit on coastal ecosystem (physico-chemical and biological parameters)	2
CLO3	Discuss about the Sundarban river estuary.	1
CLO4	Explain species diversity index in estuarine, coastal and marine habitats.	2
CLO5	Exploit the food web in coastal, estuarine or brackish water habitat and mangrove ecosystem.	1

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Acquaintance with the equipment used in the coastal and marine field study.	- Lectures followed by discussion - Participatory question-answer	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/
CLO2	Field visit on coastal ecosystem (physico-chemical and biological parameters) with special reference to estuarine and mangrove community	- Lectures followed by discussion - Direct field visit and demonstration	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
	and modification.		Presentation/ Spotting, etc)
CLO3	Field visit and study of the Sundarban river estuary as an Estuarine Ecosystem of Bangladesh.	- Lectures followed by discussion - Direct field visit and demonstration	
CLO4	Study of species diversity index in estuarine, coastal and marine habitats	- Lectures followed by discussion - Participatory question-answer	
CLO5	Field Visit and Study on the Food Web in Coastal, Estuarine or Brackish water Habitat and Mangrove Ecosystem.	- Lectures followed by discussion - Direct field visit and demonstration	

0831-1215: Practical on Physico-chemical Limnology

Credit: 1
Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe the morphometric characters of waterbody.	2
CLO2	Evaluate area and volume of the waterbody.	2
CLO3	Analyze the physical properties of different waterbodies.	2
CLO4	Categorize and relates the physico-chemical properties of soil.	2
CLO5	Analyze the chemical properties of different waterbodies.	3
CLO6	Recognize and summarize a salient feature on lotic waterbodies.	3

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Studies of waterbody morphometry: ponds, lakes, river etc.	-Lecture -Demonstration	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc)
CLO2	Method for determining area and volume of ponds, lakes and reservoirs.	- Lecture -Demonstration	
CLO3	Recording of temperature, turbidity, transparency, colour, light penetration and flow of different waterbodies.	- Lecture - Field work -Lab work	
CLO4	Methods of sampling bottom soil, determination of pH, moisture content, organic carbon and total nitrogen.	- Lecture - Field work -Lab work	
CLO5	Chemical analysis of dissolved oxygen, free CO_2, pH, alkalinity, total hardness, phosphate, nitrate, nitrite, ammonia, calcium, iron, silica and salinity of different water bodies.	- Lecture - Field work -Lab work	
CLO6	Field visits and reports writing on limnological study of rivers and streams etc.	- Field work	

0831-1216: Practical on Fisheries Microbiology

Credit-1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Demonstrate the Gram's stain, spore stain, flagella stain, Ziehl-Neelsen's stain, Hiss's methods and Albert's staining.	3
CLO2	Isolate and identify the bacteria by morphological, biochemical, and physiological study.	2
CLO3	Isolate and identify the bacteria by serological study.	2
CLO4	Estimate and calculate total bacterial count by consecutive decimal dilution method.	2
CLO5	Estimate and calculate total bacterial count by most probable number method.	2
CLO6	Perform sample collection from selected fish landing centers, fish markets and processing plants for bacteriological analysis; prepare a report.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Microscopic observation of bacteria: Gram's stain, spore stain, flagella stain, Ziehl-Neelsen's stain, Hiss's methods and Albert's staining.	- Lectures - Laboratory Experiment	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Isolation and identification of bacteria: Morphological, biochemical, and physiological study.	- Lectures - Laboratory Experiment	
CLO3	Isolation and identification of bacteria: Serological study.	- Lectures - Laboratory Experiment - Analyzing data	
CLO4	Quantitative estimation of bacteria: Consecutive decimal dilution method.	- Lectures - Laboratory Experiment - Analyzing data	
CLO5	Quantitative estimation of bacteria: Most probable number method.	- Lectures - Laboratory Experiment - Analyzing data	
CLO6	Field visit: Sample collection from selected fish landing centers, fish markets and processing plants for bacteriological analysis and preparation of report.	- Lectures - Laboratory Experiment - Analyzing data	

Viva-voce Course

0831-1221: Viva-voce

Credit: 1
Full marks: 100

Course Learning Outcomes (CLOs):

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

CLOs	Course Learning Outcomes	Sessions
CLO1	Communicate and express verbally the knowledge obtained in an effective and clear manner	12

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X

B. Sc. Fisheries (Honours) 2nd Year 1st Semester Examination, January-June 2025

Theoretical Courses

0831-2101: Fish Physiology

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and essential to understand the physiology, anatomy and classification of fishes based on thermal regulations. The course focuses on the physiological processes in fish including respiration, circulation, osmoregulation and ionic regulation, endocrinology, digestion, metabolism, growth and reproduction. The student should therefore have a basic understanding of physics and chemistry related to these mechanisms and in the environment.

Learning Outcomes:

At the end of the course, the students will be able to understand the thermal regulation of fish, digestion mechanism, phases of metabolism, physiologic of respiration, excretory products, osmoregulation in freshwater and marine fishes.

After finishing this course, the students will able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Define the physiology, anatomy and classify the fishes based on thermal regulation including homeotherms, poikilotherms and endotherms.	4
CLO2	Describe the digestion, digestion mechanism, digestive secretion (function of HCl and role of bile), sources of enzymes and its function, absorption and assimilation. Also, know the metabolism, phases of metabolism, anabolism, catabolism and its classification based on activity levels, water and solute metabolism, cellular metabolism and factors controlling metabolism in fish.	4
CLO3	Describe the physiology of respiration, transport and exchange of gases, factors affecting O_2 and hemoglobin affinity, respiratory volume and respiratory quotient of fishes. Also, know the excretory products, biochemical composition of excretory products and physiology of excretion.	4
CLO4	Discuss the Osmosis, osmotic pressure, isotonic, hypotonic, hypertonic, uryhaline, stenohaline, electrolytes, osmoregulation in freshwater, marine and migratory fishes. Also, describe the composition and function of blood, mechanism and physiology of blood circulation, heart structure, myocardial electrical activity, cardiac flow and heart volume.	4
CLO5	Know the hormone secretion and their role in the life process of fishes and its application to breeding purposes.	4
CLO6	Know the concept of age and growth and its estimation methods and factors	8

CLOs	Course Learning Outcomes	Lectures
	affecting on it. Also, describe the physiology of reproduction, classification, Ovarian maturation stages, sexual maturity and reproductive cycle.	

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	**Introduction to Physiology**: Definition of physiology, anatomy, Classification of fish based on thermal regulation, low and high thermal effect, temperature regulation in homeotherms, fish as poikilotherms, endothermic fishes.	Lectures followed by discussion Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	**Digestion:** Concept of digestion, digestion mechanism, digestive secretion (function of HCl and role of bile), sources of enzymes and function, absorption and assimilation. **Metabolism:** Concept of metabolism, phases of metabolism: anabolism and catabolism, classification of metabolic rate based on activity levels, water and solute metabolism, cellular metabolism, factors controlling metabolism in fish.	Lectures followed by discussion Participatory question-answer Online resources	
CLO3	**Respiration:** Definition, physiology of respiration, transport and exchange of gases, factors affecting O_2 and hemoglobin affinity, respiratory volume, respiratory quotient. **Excretion:** Definition and concept on excretory products, biochemical composition of excretory products, physiology of excretion.	Lectures followed by discussion Participatory question-answer Online resources	
CLO4	**Osmoregulation:** Osmosis, osmotic pressure, isotonic, hypotonic, hypertonic, uryhaline, stenohaline,	Lectures followed by discussion Participatory question-	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
	electrolytes, osmoregulation in freshwater, marine and migratory fishes. **Blood circulation:** Composition and function of blood, mechanism and physiology of blood circulation, heart structure, myocardial electrical activity, cardiac flow, heart volume	answer Online resources	
CLO5	**Endocrine system:** Hormone secretion and their role in the life process of fishes, hormone versus fish behaviour (specially breeding and migratory).	Lectures followed by discussion Participatory question-answer	
CLO6	**Growth:** Definition and general concept of age and growth, methods for estimation of age and growth, and factors affecting growth. **Reproduction:** Physiology of reproduction, classification of reproductive strategies, Ovarian maturation stages, sexual maturity and reproductive cycle.	Lectures followed by discussion Participatory question-answer	

Recommended literature:

1. The Physiology of Fishes. Vol.-I & II. Brown, M. E. (1957). Academic Press, London.
2. The Physiology of Fishes. Vol.-III & IV. Brown, M. E. (1957). Academic Press, London.
3. Fish Physiology, Vol.-I. W. S. Hoar & D. J. Randall (1969). Academic Press, New York & London.
4. Modes of Reproduction in Fishes. C. M. Jr. Brender and D. E. Resen. 1966. Natural Histroy Press, New York.
5. An Introduction to Fishes. S. S. Khanna (1981). Indian University Press, Allahabad, India.
6. Introduction to Fish Physiology by Dr. Lynwood, S. Smith (2003). NPH, New Delhi.
7. Fish and Fisheries (2nded) by Pandey, Shukla (2007).Rakesh Kumar Rastogi Publications, Shivaji Road, Meerut, India.

0831-2102: Molecular Biology and Histology

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This is a theoretical course and prerequisite for completing 4-year B.Sc. in Fisheries (Honours) degree. The course describes the ultracellular structure and function of cell organelles and

histological process. It will explore the interface between genetics and biochemistry, emphasizing on the molecular-level understanding of genetics including replication, transcription, and translation, gene expression and mutation.

Learning Outcomes:

At the end of the course, the students will be able to know the structure and function of cell, chromosome and gene along with the molecular basis of genetics. The students will also be acquainted with crossing over, gene expression, fish genomes and histological process. This course will help in understanding some other courses like fish genetics and biotechnology.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe background, importance and scope of molecular biology and histology.	1
CLO2	Describe structure, function and chemistry of cell organelles (plasma membrane, endoplasmic reticula, Golgi bodies, lysosome, mitochondria)	6
CLO3	Explain the types, structure and functions of fish tissue.	5
CLO4	Generalize the events of cell cycle and cell division. Describe types, theory, mechanism, factors and significance of crossing over.	5
CLO5	Understand and describe the structure, chemical composition, and changes in structure and number of chromosome.	2
CLO6	Understand and describe about gene expression with emphasis on DNA replication, transcription, translation and genetic code. Explain nuclear and mitochondrial gene structure and genomes in fishes.	5

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Background, pioneer, objective, expected outcome, importance and scope of the course.	-Lectures followed by discussion -Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	**Cell-types and structures**: Structure, function and chemistry of cell organelles (plasma membrane, endoplasmic reticula, Golgi bodies, lysosome, mitochondria)	-Lectures followed by discussion -Participatory question-answer	
CLO3	**Histology**: types, function, structure and functions of fish tissue.	-Lectures followed by discussion -Participatory question-answer	
CLO4	**Cell cycle and cell division**: Mitosis and meiosis. Crossing over: Definition, types, theory, mechanism, factors and significance.	-Lectures followed by discussion -Participatory question-answer	
CLO5	**Chromosome**: structure, chemical composition, changes in structure, variation in number.	-Lectures followed by discussion -Participatory question-answer	
CLO6	**Gene expression**: DNA replication, transcription, translation, genetic code. Genomes in fishes: Nuclear and mitochondrial gene structure.	-Lectures followed by discussion -Participatory question-answer	

Recommended literature:

1. Handbook of histological and cytological techniques, R. R. Benstey.
2. The Cell Structure. C. P. Swanson.
3. Cells and Organells, A. V. Novikoff and E. Holtzman.
4. Cytological Technique, J. R. Baker (1966), John Wiley and Sons. Inc., New York.
5. Basic Histology, L. C. Junqueira and J. Carneuro (1971), Lange Medical Publ., Los Altos, California.
6. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. P.S. Verma and V.K. Agarwal (2006) S. Chand and Company Ltd. New Delhi.
7. Molecular & Cell Biology for Dummies. René Fester Kratz (2009). Wiley Publishing, Inc., Indianapolis, Indiana.
8. Histological techniques for marine bivalve mollusks and crustaceans. Howard, D. W., E. J. Lewis, B. J. Keller, and C. S. Smith. (2004). NOAA Technical Memorandum NOS NCCOS 5.

0831-2103: Fish Behaviour

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This is a basic theoretical course and prerequisite for completing 4-year B.Sc. in Fisheries (Honours) degree. This course covers different behaviours of aquatic organisms with special reference to animal personality with a view to understanding the biology and ecology of fishes. This course has been designed to enhance students' knowledge of fish behaviours and their actual and potential role in the life history and management of a species.

Expected Outcomes:

Upon completion of the course the students will be able to understand the importance of various fish behaviours and would be able to use this knowledge in the management of the species concerned. At the end of the course the students would be able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Develop the basic concept of fish behaviour and explain its significance in fisheries science (especially aquaculture, fisheries management and harvest technology). Understand and explain different types of fish behaviours along with their mechanisms and theories.	5
CLO2	Explain the feeding behaviours of fishes and effectively suggest / employ this knowledge in aquaculture, open water management and species conservation activities.	3
CLO3	Explain the reproductive behaviours of various important fishes and effectively suggest / employ this knowledge in managing any stock.	6
CLO4	Explain the significance of migratory behaviours of fishes and effectively suggest / employ this knowledge in managing any stock.	4
CLO5	Explain the significance of parental care of fishes and effectively suggest / employ this knowledge in managing any stock. Explain special behaviours of fishes (e.g. aestivation and hibernation) and effectively explain or employ this knowledge in managing any stock.	6
CLO6	Understand and explain the role of animal personality and its uses in modern science and fisheries management.	4

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □, No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategies	Assessment Strategy
CLO1	Basic terminologies of animal behaviour; kinds, mechanism and theories of behaviour	- Lectures followed by discussion	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	Feeding behaviour of fishes	- Lectures followed by discussion - Multimedia presentation	
CLO3	Reproductive behaviour of aquatic species	- Lectures followed by discussion - Multimedia presentation	
CLO4	Migratory behaviour of aquatic species	- Lectures followed by discussion - Multimedia presentation	
CLO5	Parental care of fishes; special behaviours in aquatic animals	- Lectures followed by discussion - Multimedia presentation	
CLO6	Animal personality and its uses in fisheries management	- Lectures followed by discussion - Multimedia presentation	

Recommended literature:

1. Halfman GS, Collette BB and Facey DE (2000) *The Diversity of Fishes*, Blackwell Science, USA
2. Kotpal RL (2000) *Modern Textbook of Zoology: Verebrates* (2nd edition). New Delhi, India.
3. Lucas MC and Baras E (2001) *Migration of freshwater fishes*. Blackwell Science.
4. Parker TG and Haswell WS (1960) *Text Book of Zoology*, Vol. II (7th edition). McMillan Co. Ltd., London.
5. Storer TI and Usinger RL (1965) *General Zoology*. McGraw Hill Book Co., New York.
6. Young JZ (1962) *The Life of Vertebrates*. Oxford University Press, London.

0831-2104: Fish Nutrition

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course will be intended to basic theoretical knowledge for complete B. Sc. in Fisheries (Honours) degree with 8 semesters. The course introduces with different aspects of fish nutrition. The fish requires different types of nutrients for its growth, health and maintenance. The various nutrients required by fish and shellfish include proteins, lipids, carbohydrates, vitamins and minerals. The course highlights include the nutrition, fish and shellfish nutrition, protein requirement in fish nutrition,Lipids requirement in fish nutrition, Carbohydrates in fish nutrition, minerals and vitamins requirement in fish nutrition. The course is designed to strengthen existing knowledge on nutritional requirement of deferment nutrition. This course provides knowledge on sources of nutrition in water for fish and shellfish and also explain on the various nutritional factors to improve nutritional status of culturable species in Bangladesh. shellfish species are presented.

Learning Outcomes:

At the end of the course, the students will be able to know about the fish nutrition concerning the nutrient- carbohydrate, protein, lipid and also vitamin and mineral requirement of fish, crustacean and mollusc etc.
At the end of the course, the students will be able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Define different terminology and importance of fish nutrition.	2
CLO2	Explain nutritional value of protein, optimum dietary protein level, Dietary Protein and amino acid requirement of fish and shell fish, Function of protein in fish and crustaceans.	4
CLO3	Compute minerals requirement of fish and shrimp, dietary sources of minerals, Biological function of calcium and phosphorus in fish.	3
CLO4	Describe lipids and fatty acids, dietary lipids requirement of fish, Essential fatty acids requirement of fish. Fatty acid oxidation, Toxic non-essential fatty acids. Problems with higher dietary lipid levels in fish feed.	4
CLO5	Understand Carbohydrates requirement. Function of carbohydrates in aquatic animals. Dietary utilization of carbohydrates in fish.	3
CLO6	Describe application of sources of nutrition**:** naturally produced food in ponds; food produced through fertilization and supplementary feeding and complete artificial feeding. Discuss the vitamins, Individual vitamins, Vitamins requirement of fish, dietary sources of vitamins	4

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	**Introduction:** Introduction and terminology of fish nutrition; nutritional parameters of culturable fish and shellfish; importance of fish nutrition. Application of fish Nutrition and human health.	- Lectures followed by discussion - Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO2	**Proteins:** Proteins and amino acids, Optimum dietary protein level, Dietary Protein and amino acid requirement of fish and shell fish, Function of protein in fish and crustaceans.	- Lectures followed by discussion - Participatory question-answer - Online resources	Test: 20 Final Examination: 70
CLO3	**Minerals**: Minerals requirement of fish and shrimp, dietary sources of minerals, Biological function of calcium and phosphorus in aquatic animals.	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO4	**Lipids:** Lipids and fatty acids, dietary lipids requirement of fish, Essential fatty acids requirement of fish. Fatty acid oxidation, Toxic non-essential fatty acids. Problems with higher dietary lipid levels in fish feed.	- Lectures followed by discussion - Participatory question-answer - Online resources - Video demonstration	
CLO5	**Carbohydrates:** Carbohydrates and water. Function of carbohydrates in aquatic animals. Dietary utilization of carbohydrates in fish.	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO6	**Sources of nutrition:** naturally produced food in ponds; food produced through fertilization and supplementary feeding and complete artificial feeding. Vitamins, Individual vitamins, Vitamins requirement of fish, dietary sources of vitamins	- Lectures followed by discussion - Participatory question-answer - Online resources	

Recommended literature:

1. Fish Nutrition(2nd edn.). 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. Backyard Fish Farming. P. Bryant, K. Jauncey and T. Atack (1982). Frism Press. Stable Court. Dorchester, England.
5. Finfish Nutrition and Fish Feed Technology. vol. I and II. J. E. Halver and K. Tiews (editors) (1979). NeenemannGmbh and Co. Berlin.
6. Nutrient Requirement of Warm Water Fishes and Shellfishes. National Research Council (1988). National Academy of Sciences; Washington DC.
7. Energetics: New Perspectives. P. Tytler and P. Calow (editors) (1985). 8. Croom Helm. London.

8. Fish Nutrition in Asia. ICLARM.
9. Applied Nutrition by D. V. Reddy (2006). Vijay Primlani for Oxford of IBH Publishing Co. Pvt. New Delhi.
10. Fish is Nutrition. E. Heen and R. Krenzer (1962). Fishing News (Books) Ltd. London.

0831-2105: Fish Parasitology

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete 4-year B. Sc. in Fisheries (Honours) degree. The course covers the understanding of fish parasites and parasitic problems in cultured fish. The course designed to strengthen the student's knowledge on parasitic diseases in fish and the correct diagnosis methods of pathogenic parasites. This course can also teach them ecology, morphological adaptation and life cycle of fish parasites. This course will also be focused on appropriate prevention and control methods of parasitic problems in culture environment and fish stocks.

Learning Outcomes:

At the end of this course, the students will be able to: i) Identify, classify and explain fish parasites; know and explain their life cycle and morphological adaptation; ii) Understand the interrelation among parasites, host and environment; iii) Discuss effects of parasites on fish; iv) Explain various methods use in controlling fish parasites and diseases. At the end of the course, the students will be able to-

CLOs	**Course Learning Outcomes**	**Lectures**
CLO1	Define parasite, parasitology and fish parasitology; describe the importance of fish parasitology and major groups of fish parasites.	3
CLO2	Understand the concept and importance of symbiosis and parasitism; describe the types of symbiosis and parasitism.	3
CLO3	Describe the life cycle of some representative fish parasites (*Gyrodactylus* sp., *Dactylogyrus* sp., *Clinostomum* sp., *Clonorchis* sp., *Ligula* sp., *Proteocephalus* sp. etc.)	4
CLO4	Explain the host-parasite-environment relationship; describe the factors influencing abundance and composition of fish parasites; explain the adaptation of parasites and their mode of life in host body	5
CLO5	Describe the affecting ways of parasite on its host and host's reaction to the parasites.	4
CLO6	Exploit the etiology, affected host, affected sites, symptoms and pathology transmission process, preventive and control measures of parasitic diseases in fish.	5

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	**Introduction:** Definition of parasite, parasitology and fish parasitology, importance of fish parasitology, major groups of fish parasites.	- Lectures followed by discussion - Participatory question-answer - Slide show	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	**Symbiosis and parasitism:** Concept, importance and types of symbiosis; concept and types of parasitism	- Lectures followed by discussion - Online resources	
CLO3	**Life cycle of some representative fish parasites:** *Gyrodactylus* sp., *Dactylogyrus* sp., *Clinostomum* sp., *Clonorchis* sp., *Ligula* sp., *Proteocephalus* sp. etc.	- Lectures followed by discussion - Online resources	
CLO4	**Environment and fish parasites:** Host-parasite-environment relationship, factors influencing abundance and composition of fish parasites; **Adaptation of parasites and their mode of life:** Body shape, size, colour and structure-attachment and locomotion organs, different systems.	- Lectures followed by discussion - Online resources	
CLO5	**Effects of parasite on its host and host's reaction to the parasites:** Mechanical effects, toxic effects, effects as vector and as indirect causes of diseases, others effects; cell and tissue reactions and immunity of host.	- Lectures followed by discussion - Online resources	
CLO6	**Parasitic diseases of fish:** Etiology, affected host, affected sites, symptoms and pathology, transmission process, preventive and control measures.	- Lectures followed by discussion - Online resources - Video demonstration	

Recommended literature:

1. Parasites and Diseases of Fish Cultured in the Tropics. Z. Kabata. (1985). Taylor and Francis.
2. Illustrated Laboratory Manual of Parasitology. R. M. Cable. (1983). Burgess Publ. Co. Miniapolis, New York, San Francisco, London.
3. Parasitology of Fishes. V. A. Dogiel. (1962). G. K. Pet Rushevsky and T. L. Polyansky (editors). Oliver and Boyd. Edinburgh and London.
4. Parasitology of Fishes. Markov. G. S. (1961). Oliver and Boyd, Edinburgh and London.
5. Parasitology of Fishes (Ecology of the parasites of freshwater fishes). V. A. Dogiel (1961). Oliver and Boyd, Edinburgh and London.
6. Aquaculture Parasitology: Pathogens of Fish, Crustaceans, and Molluscs. Freeman, Mark A., and Frederick S. B. Kibenge. Elsevier Science & Technology Books, 2020.
7. Parasitic diseases of fish. Dyfed: Samara in association with the British Society for Parasitology and the Linnean Society of London, 1994.

0831-2106: Fish Food Chemistry

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite for understanding of courses related to fish processing, preservation and quality control. This course provides the students with an understanding of the proximate composition (protein, lipid, carbohydrates, minerals and ash) of fish and shellfish for the development of quality products and storage condition. This course also covers basic understanding of post-mortem changes in fish and shellfish. In addition, flavouring compounds and bio-toxins in seafood will be discussed too.

Learning Outcomes:

At/by the end of the course, the students will be able to i) know about the chemical composition of fish and shellfish; ii) understand the post mortem changes in fish; and iii) know about the flavor compound and bio-toxin production in fish and shellfish.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Define food and nutrition; nutritional composition of food; Define Fish Food Chemistry; Know importance and scope of fish food chemistry. Describe physical structure, properties and chemical composition of fish and shellfish muscles. Explain the role of body constituents in governing fish quality and processability.	4
CLO2	Outline and apply proteins in fishes and their changes during processing and	3

CLOs	Course Learning Outcomes	Lectures
	preservation of fish and shellfish.	
CLO3	Outline and apply lipid and fatty acids in fishes and their changes during processing and preservation of fish and shellfish.	3
CLO4	Explain and apply post-mortem changes and rigor-mortis in fish and their influencing factors.	6
CLO5	Outline and apply minor constituents in fish and shellfish (minerals, vitamins and flavouring compounds etc.) and effect of processing and preservation on vitamin and mineral composition.	6
CLO6	Outline and describe bio-toxins in marine vertebrates, invertebrates, seaweed and plankton.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Introduction: Food and nutrition; scope and significance of studying fish food chemistry; Physical structure and properties of fish and shellfish muscles; Chemical composition of fish and shellfish; Role of body constituents in governing fish quality and processability.	Lectures followed by discussion Participatory question-answer Online resources	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	Protein in fish: Protein content, protein groups, nutritive value, denaturation and spoilage of protein, stability of muscle proteins under various conditions, gelation properties of fish muscle proteins, changes of protein during processing and preservation of fish and shellfish.	Lectures followed by discussion Participatory question-answer Online resources	
CLO3	Lipid in fish**:** Lipid types and their variations, polyunsaturated fatty acids, essential fatty acids, denaturation and	Lectures followed by discussion Participatory question-	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
	rancidity of seafood lipid, convenience food and modern diet.	answer Online resources	
CLO4	Post-mortem changes in fish: Definition; degradation of organic phosphates and carbohydrates; post-mortem bacteriological changes; rigor-mortis in fish; physical and bio-chemical changes in rigor-mortis; factors influencing rigor-mortis.	Lectures followed by discussion Participatory question-answer Online resources	
CLO5	Minor constituents in fish and shellfish: -Macro and trace elements in fish and shellfish -Fat- and water-soluble vitamin content in small fish, farmed fish and marine fish; effect of processing and preservation on mineral and vitamin content. -Flavour compounds of seafood **(**Nitrogenous and volatile compounds)	Lectures followed by discussion Participatory question-answer Online resources Video demonstration	
CLO6	Marine bio-toxins: Introduction, toxin in marine vertebrates, invertebrates, seaweed and plankton.	Lectures followed by discussion Participatory question-answer	

Recommended literature:

1. Fish as food. vol. I-IV. G. Borgstrom (editor) (1965). Academic press, London.
2. Food Chemistry, Edited by H.-D. Belitz· W. Grosch · P. Schieberle. 4th revised and extended ed. 2009. Springer-Verlag Berlin Heidelberg, 617-639.
3. Fish Processing Technology, Hall, G. M. 1997 (ed.). 2nd Edition. Blackie Academic & Professional, London, Weinheim, New York, Melbourne, Madras. 309 pp.
4. Quality assurance in Fish Industry. In Development in Food Science, Huss, H. H., M. Jakobsen and J. Liston. 1992. Elsevier, Amsterdam, London, New York, Tokyo. 587 pp.
5. Fish and Fishery Products: composition, nutritive properties and stability, Ruiter, A. 1995. Cab International, Oxon, UK. 387 pp.
6. Post-harvest Technology of Fish and Fish Products. Balachandran, K. K. 2001. Daya Publishing House, Delhi–110035. India. 440 pp.
7. Textbook of Fish Processing Technology, Gopakumar, K. 2002 (ed.). Indian Council of Agricultural Research, New Delhi.
8. Safety and quality issues in fish processing, Edited by H. Allan Bremner. 2002, Woodhead Publishing Limited and CRC Press LLC

Practical Courses

0831-2111: Practical on Fish Physiology

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Estimate the age and growth of aquatic animals through hard-part analysis and length-frequency analysis	3
CLO2	Prepare the blood smears (preparation and microscopic study).	2
CLO3	Estimate the maturation stages of gonads in different size of fishes, GLI and GSI.	3
CLO4	Collect and prepare the PG extract for induced breeding of fishes.	2
CLO5	Compare the digestive tracts of fishes having different food habit through dissection.	2
CLO6	Estimation of physiological status of fish.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Age and growth estimation using hard-part analysis and length-frequency analysis	- Lectures - Laboratory experiment - Analyzing data	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Preparation of blood smears (preparation and microscopic study).	- Lectures - Laboratory experiment - Analyzing data	
CLO3	Study of maturation stages of gonads in different size of fishes, GLI and GSI.	- Lectures - Laboratory experiment - Analyzing data	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO4	Collection and preparation of PG extract for induced breeding of fishes.	- Lectures - Laboratory Experiment	
CLO5	A comparative study on the digestive tracts of fishes having different food habit.	- Lectures - Laboratory Experiment	
CLO6	Estimation of physiological status of fish.	- Lectures - Laboratory experiment	

0831-2112: Practical on Molecular Biology and Histology

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Outcomes	Lectures
CLO1	Prepare and apply metaphasic chromosome slide.	1
CLO2	Explain and apply temporary slide preparation of fish tissue.	2
CLO3	Explain and apply histological techniques for permanent slide preparation of fish tissue.	1
CLO4	Perform and apply permanent slide preparation of fish tissue.	3
CLO5	Identify permanent histological slides of fishes.	4

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Preparation of metaphasic chromosome slide.	- Lectures - Online resources	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60
CLO2	Temporary slide preparation of fish	- Lectures	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
	tissue.	- Laboratory experiment	(Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO3	Histological techniques for permanent slide preparation of fish tissue.	- Lectures followed by discussion - Participatory question-answer - Demonstration	
CLO4	Permanent slide preparation of fish tissue.	- Lectures - Laboratory experiment	
CLO5	Identification of permanent histological slides of different fish tissue.	- Lectures - Laboratory experiment	

0831-2113: Practical on Fish Behaviour

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Recognise, identify and describe different behaviour relevant to reproduction and parental care of fishes.	3
CLO2	Identify and justify feeding behaviours of fishes in relation to their morphological adaptations.	3
CLO3	Recognise and justify respiratory behaviours of air breathing and non-air breathing fishes.	3
CLO4	Identify and justify responses of fishes to different physico-chemical stimuli.	2
CLO5	Identify migratory species and their migration routes	3

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □, No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategies	Assessment Strategy
CLO1	Study of different types and stages of reproductive behaviour and parental care found in fishes.	- Lectures - Multimedia presentations - Question and answer	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting / others)
CLO2	Study of feeding behaviour with special relationship to morphological adaptation of feeding organs found in fishes.	- Lectures - Multimedia presentations - Question and answer	
CLO3	Observations on respiratory behaviour of air breathing and non-air breathing fishes.	- Lectures - Multimedia presentations - Question and answer	
CLO4	Observations on responses of fishes to different physical and chemical stimuli.	- Lectures - Multimedia presentations - Question and answer	
CLO5	Study of migratory species and their migration routes	- Multimedia presentations - Question and answer - Mapping	

0831-2114: Practical on Fish Nutrition

Credit: 1
Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Recognize nutritional laboratory equipment and suggest safety measures.	2
CLO2	Accustom with Methods of sampling and preparation of sample for analysis.	2
CLO3	Recognize available fish feed ingredient and their nutritional composition.	2
CLO4	Determine and demonstrate Proximate analysis of feed ingredients. Quantify nutritional parameters and protein utilization parameters	2
CLO5	Estimate calorific value of food stuffs.	2
CLO6	Understand and apply nutritional disorders in fishes.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Introduction to nutritional laboratory equipments and safety procedure.	- Lectures - Problem solve	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Methods of sampling and preparation of sample for analysis.	- Lectures - Problem solve	
CLO3	Recognized available fish feed ingredient and their nutritional composition	- Lectures - Laboratory experiment	
CLO4	Determination of Proximate analysis of feed ingredients and compounded feed samples :moisture and lipid	- Lectures - Laboratory Experiment	
CLO5	Study of Nutritional parameters as well as protein utilization parameters	- Lectures - Laboratory Experiment	
CLO6	Estimation of calorific value of various food stuffs by Bomb Calorimetry.	- Lectures - Laboratory experiment	
CLO6	Understand and apply nutritional disorders in fishes.	- Lectures - Problem solve	

0831-2115: Practical on Fish Parasitology

Credit: 1
Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Outcomes	Lectures
CLO1	Perform investigation techniques for collecting of fish parasites	2
CLO2	Perform fixation and preservation techniques of fish parasites	2

CLOs	Course Outcomes	Lectures
CLO3	Exploit pathogenic parasites occur in fish	2
CLO4	Perform collection and identification techniques of parasites from infected fish	**2**
CLO5	Compute parasitic abundance in affected fish	**2**
CLO6	Calculate chemical requited for controlling parasitic diseases	**1**

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Techniques of investigation of fish for collecting parasites	· Lectures followed by discussion · Laboratory Experiments	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Techniques of fixation and preservation of fish parasites	· Lectures followed by discussion · Laboratory Experiments	
CLO3	Study of some pathogenic fish parasites	· Lectures followed by discussion · Slide show	
CLO4	Collection and identification of parasites from infected fish specimens	· Lectures followed by discussion · Laboratory Experiments	
CLO5	Quantitative study of fish parasites	· Lectures followed by discussion · Laboratory exercise	
CLO6	Calculate chemical requited for controlling parasitic diseases	· Lectures followed by discussion · Laboratory exercise	

0831-2116: Practical on Fish Food Chemistry

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Determine major component of fish flesh	3
CLO3	Determine post-mortem changes in fish and nature of spoilage	2
CLO4	Determine proximate composition of fish	3
CLO5	Extract actomyosin from fish and determine protein by Biuret method	2
CLO6	Describe and outline marine bio-toxins.	1

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Determination of major components of fish flesh.	- Lectures - Problem solve	**Full marks: 100** Attendance :10 Class record/Record:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
COL2	Study of post-mortem changes in fish and nature of spoilage.	- Lectures - Problem solve	
CLO3	Study of proximate composition of fish: moisture, ash, crude lipid and crude protein.	- Lectures - Laboratory experiment	
CLO4	Extraction of actomyosin from fish muscle and determination of protein by Biuret method.	- Lectures - Laboratory Experiment	
CLO5	Determination of non-protein nitrogen in fish.	- Lectures - Laboratory Experiment	
CLO6	Study of marine bio-toxins.	- Lectures - Laboratory experiment	

B. Sc. Fisheries (Honours) 2nd Year 2nd Semester Examination, July-December 2025

Theoretical Courses

0831-2201: Biological Limnology

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete 4-year B. Sc. in Fisheries (Honours) degree. The course covers abundance and distribution of algae, harmful algal bloom and their toxins, zooplankton, benthos, periphyton and aquatic weeds, in aquatic environment. The course is designed to strengthen the student's existing knowledge on biological features, productivity and pollution status of inland waterbodies. This course can also teach them about interrelationship between different aquatic organisms in aquatic ecosystem. A number of further topics, like, classification of plankton, seasonal succession of phytoplankton, detection techniques and abatement of pollution will be also focused in the course

Learning Outcomes:

At/by the end of the course, the students will be able to understand i) abundance and distribution of algae, zooplankton, benthos, periphyton and aquatic weeds, and ii) ecological interaction and interrelationship between different organisms in aquatic environment.
At the end of the course, the students will be able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Define limnology and biological limnology; describe different types of aquatic organisms; explain about classification of plankton.	2
CLO2	Describe different types and economic value of aquatic plants. Types of major groups of periphyton; explain role and significance of periphyton in ecosystem. Compare interrelationship between different aquatic organisms in aquatic ecosystem.	6
CLO3	Explain about major groups, growth factors and seasonal succession of phytoplankton; Describes and compares eutrophication and phytoplankton bloom. Discuss about toxic and noxious phytoplankton. Describe Harmful Algal Bloom (HABs); explain about different toxin producing algal species and their ecology in aquaculture ponds.	5
CLO4	Explain major groups, life cycle and cyclomorphosis of zooplankton; describe food & feeding habit and migration of zooplankton.	2
CLO5	Discuss about major groups and factors affecting the abundance and distribution of benthos; explain the role of benthos in aquatic environment.	3

CLOs	Course Learning Outcomes	Lectures
CLO6	Explain sources of pollution and impact of pollution on aquatic organisms; Discuss about the detection techniques and abatement of pollution.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	**Introduction:** Definition of limnology and biological limnology, types of aquatic organisms, general classification of plankton.	Lectures followed by discussion Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	**Aquatic plants:** Definition, types, significance, aesthetic and economic value. **Periphyton:** Definition, major groups, significance in ecosystem. **Ecological interaction and interrelationship:** Interrelationship between phytoplankton and zooplankton; interrelationship among phytoplankton, zooplankton and fish; interrelationship between benthos and fish, aquatic vascular plant and fish, plankton and benthos, bacteria and diatoms.	Lectures followed by discussion **Participatory question-answer**	
CLO3	**Phytoplankton:** Definition, major groups, growth factors, seasonal succession, association, eutrophication, phytoplankton bloom, toxic and noxious phytoplankton. **Algal Toxins in Pond Aquaculture:** Harmful algal bloom (HAB), Cyanobacterial ecology and toxins, Prymnesiophytes ecology and toxins, Euglena ecology and toxins in	Lectures followed by discussion Participatory question-answer Demonstration picture	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
	aquaculture pond.		
CLO4	**Zooplankton:** Definition, major groups, life cycle, cyclomorphosis, food and feeding habit, abundance, distribution and vertical migration.	Lectures followed by discussion Demonstration picture	
CLO5	**Benthos:** Definition, major groups, factors affecting the abundance and distribution, role in aquatic environment	Lectures followed by discussion Participatory question-answer	
CLO6	**Aquatic pollution:** Definition, sources, impacts on the aquatic organisms, detection and abatement.	Lectures followed by discussion **Participatory question-answer**	

Recommended literature:

1. Text Book of Limnology, G. A. Cole (1979), The Mosby Co., London.
2. Limnology, C. R. Goldman and A. J. Horne (1983), McGraw Hill Book Co.
3. A Treatise on Limnology vol. I and II, G. E. Hutchinson (1975), John Wiley and Sons, New York.
4. Limnology, P. S. Welch (1952), McGraw Hill Book Co.
5. Limnology, R. G. Wetzel (1983), Saunders College Publ., Philadelphia, USA.
6. Fundamentals of Limnology (3rd edn), Franz Ruttner (1970), Walter de Gruyter& Co., Berlin.

0831-2202: Fisheries Systematics

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete four years B.Sc. Fisheries (Honours) degree. The course covers the history of biological taxonomy and systematic, taxonomic characters in fishes, taxonomic collection, labeling, preservation and cataloguing of fish and other fisheries items, identification of fishes using taxonomic keys. The course is designed to strengthen the student's existing knowledge on fisheries systematics. A number of further topics, like the, categories and basis of classification, zoological nomenclature, synonyms, synonymy, law of priority, the type method, species concept will be also focused in the course.

Learning Outcomes:

At the end of the course, the students will be able to: i) know about the identification of fish, taxonomy of fish, origin & evolution of fish, ii) species & speciation; and iii) zoological nomenclature.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Know the history of biological taxonomy and systematics.	4
CLO2	Discuss about the taxonomic collection, labeling, preservation, curation and cataloguing of fish and other fisheries items. Apply to identify of fishes using taxonomic keys and other methods.	6
CLO3	Discuss types, theories, categories and basis of classification.	4
CLO4	Know zoological nomenclature, synonyms, synonymy, law of priority, the type method.	5
CLO5	Know species concept and speciation.	4
CLO6	Know origin and evolution of fishes.	5

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	History of biological taxonomy and systematics.	- Lectures followed by discussion - Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	Taxonomic characteristics: types, measurement, counting special reference to fishes and shellfishes. Taxonomic collection, labeling, preservation and curation and cataloguing of fish and other fisheries items.Identification of fishes using taxonomic keys and other methods.	- Lectures followed by discussion - Participatory question-answer	

CLO3	Types, theories, categories and basis of classification.	- Lectures followed by discussion - Participatory question-answer	
CLO4	Zoological nomenclature, synonyms, synonymy, law of priority, the type method.	- Lectures followed by discussion - Participatory question-answer	
CLO5	Species concept and speciation.	- Lectures followed by discussion - Participatory question-answer	
CLO6	Origin and evolution of fishes.	- Lectures followed by discussion - Participatory question-answer	

Recommended literature:

1. Methods and Principles of Systematic Zoology. E. Mayer (1953). McGraw Hill Book Co. New York.
2. Animal Species and Evaluation. E. Mayer (1966). McGraw Hill Book Co. New York.
3. Theory and Practice of Animal Taxonomy (4th edn), V. C. Kapoor, 1998, Oxford & IBH Publishing Co. Pvt. Ltd.
4. Principles of Animal Taxonomy, George Gaylorel Simpson, 1969, Columbia University Press.

0831-2203: Freshwater Aquaculture

Credit: 2

Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)

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

Course Description:

This course is a basic theoretical course and prerequisite for the completion of 4-year B. Sc. in Fisheries (Honours) degree. The course describes different freshwater aquaculture practices with emphasis on pond culture of carps, catfishes, tilapias, thaipunti, pangas, prawns, cuchia and crabs; cage and pen culture of commercially important fish species; integrated fish farming like paddy cum fish culture. The course also outlines the principles and pattern of good aquaculture practice. It will help the student to identify common problems of culture practice and finding possible solutions for preventing and minimizing the problem.

Learning Outcomes:

At the end of the course, the students will be able to: i) familiarize with the different freshwater aquaculture practices; ii) provide solutions to the problems of on- going freshwater aquaculture operations; iii) recognize management for commercial aquaculture including safe fish production. After finishing this course, the students will able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Demonstrate culture of commercially available fish and shellfishes.	3
CLO2	Establish and suggest cage and pen culture.	3
CLO3	Demonstrate and suggest integrated fish farming.	4
CLO4	Demonstrate and suggest aquarium-based aquaculture.	4
CLO5	Solve problems found in pond-based aquaculture.	4
CLO6	Describe and suggest about good aquaculture practices.	4

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	**Land based aquaculture:** culture of carps, catfishes, tilapias, thaipunti, pangas, prawns, cuchia and crabs.	Lectures followed by discussion Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	**Water based aquaculture:** cage culture and pen culture.	Lectures followed by discussion Participatory question-answer Demonstration picture	
CLO3	**Integrated fish farming:** definition, principle, types and practices of integrated fish farming, waste fed aquaculture.	Lectures followed by discussion Participatory question-answer Demonstration picture	
CLO4	**Aquarium based aquaculture:**	Lectures followed by	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
	Types, structure and management of aquarium; culture of ornamental fishes in aquarium.	discussion Participatory question-answer Demonstration picture	
CLO5	Common problems and their solutions to pond based aquaculture.	Lectures followed by discussion Participatory question-answer	
CLO6	**Good Aquaculture Practices:** concept, principles and practices.	Lectures followed by discussion Participatory question-answer	

Recommended 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.
8. Aquaculture Management by James W. Meade (1998). CBS Publishers, India.

0831-2204: Aquaculture Nutrition

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and condition to complete B. Sc. in Fisheries (Honours) degree with 8 semesters. This course deals with the related facets of nutrition that are regulate or enhance fish nutrition. The fish intakes the different types of nutrients for their nutrition and digested. This course covers Energy metabolism, Brood fish nutrition, Digestion in fish, larval nutrition, Digestibility of feed ingredient, Nutritional disorders, Fish nutrition and Human nutrition and Molecular nutrition in fish nutrition. The course is designed to strengthen existing knowledge

on deferment related aspects of fish nutrition. This course also provides knowledge on sources of nutrition in water for fish and shellfish.

Learning Outcomes:

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Nutritional terminology and role of nutrition in fisheries and aquaculture; Compare digestion of feed: General anatomy and organ physiology, definition of digestion, digestive fluids and enzymes secreted in teleost fish. Protein digestion, fat digestion, carbohydrate digestion, microbial digestion.	5
CLO2	Recognize absorption of nutrient in fish body, Rate of digestion, Basic methods of rate of digestion, factors affecting rate of digestion in fish,	4
CLO3	Describe nutrient requirement of larvae, feeding behaviour and its role in larval nutrition. importance of larval nutrition, Physiology of larval fish and larval feed development	4
CLO4	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 requirement of fish, factors effecting energy requirement of fish, dietary energy sources.	4
CLO5	Explain Brood stock nutrition: energy partitioning for reproduction, protein requirement of brood stock, effect of dietary quality on reproductive output, known nutritional requirements of some brood stock fishes. Analyze digestibility in fish, determination of digestibility, Markers, Factors influencing digestibility. Explain Importance of Knowledge of digestibility from an aquaculture point of view	4
CLO6	Identify nutritional disorders and suggest thereby. Describe importance of fish Nutrition on human health.	5

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Nutritional terminology and role of nutrition in fisheries and aquaculture; Compare Digestion of feed: General anatomy and organ physiology, definition of digestion, digestive fluids and enzymes secreted in teleost fish. Protein digestion, fat digestion, carbohydrate digestion, microbial digestion.	Lectures followed by discussion Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	Recognize absorption of nutrient in fish body, Rate of digestion, factors affecting rate of digestion in fish, Basic methods of rate of digestion.	Lectures followed by discussion Participatory question-answer Online resources	
CLO3	Development of Larval nutrition and growth of fish, nutrient requirement of larvae, feeding behaviour and its role in larval nutrition. Physiology of larval fish and larval feed development.	Lectures followed by discussion Participatory question-answer Online resources	
CLO4	**Energy metabolism:** 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 requirement of fish, factors effecting energy requirement of fish, dietary energy sources.	Lectures followed by discussion Participatory question-answer Online resources	
CLO5	**Brood stock nutrition:** energy partitioning for reproduction, protein requirement of brood stock, effect of dietary quality on reproductive output, known nutritional requirements of some brood stock fishes. Analyses digestibility in fish, determination of digestibility, Markers, Factors influencing digestibility.	Lectures followed by discussion Participatory question-answer	
CLO6	**Nutritional disorders:** disorders in protein nutrition, disorders in lipid nutrition, disorders in mineral deficiency, disorders in vitamin nutrition. Designed Nutrition and fish quality as well as human health.	Lectures followed by discussion Participatory question-answer Online resources	

Recommended literature:

1. Fish Nutrition(2nd edn.). 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.
5. Nutrient Requirement of Warm Water Fishes and Shellfishes. National Research Council (1988). National Academy of Sciences; Washington DC.
6. Energetics: New Perspectives. P. Tytler and P. Calow (1985). 8. Croom Helm. London.
7. Fish Nutrition in Asia. ICLARM.
8. Applied Nutrition by D. V. Reddy (2006). Vijay Primlani for Oxford of IBH Publishing Co. Pvt. New Delhi.
9. Fish is Nutrition. E. Heen and R. Krenzer (1962). Fishing News (Books) Ltd. London.

0831-2205: Fishing Technology

Credits: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and condition to complete B. Sc. in Fisheries (Honours) degree with 8 semesters. The course covers fishing gears and crafts as well as fishing techniques in all types of water bodies. Major aspects are effective and low-cost fishing method and location of fishing grounds, and preservation method of fishing gear and crafts. The course also focuses on different method of locating and detecting of fish and shellfish using different technique and fish harvesting systems

Learning outcomes:

At the end of the course the students will be able to- i) Identify fishing gears and crafts ii) Gather knowledge about the effective and low-cost fishing method and location of fishing grounds and iii) preservation method of fishing gear and crafts.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe and explain the principle and theories of fishing and fishing regulations; Define and distinguishes types of fishing and fishing equipment. Know and explain different method of locating and detecting of fish and	5

CLOs	Course Learning Outcomes	Lectures
	shellfish using different technique.	
CLO2	Define and outline about classification, materials, numbering systems and characteristics of fishing twins and gears and their preservation. Outline and distinguish fishing gears and know their operations. Classify and discuss about traditional and mechanized crafts of Bangladesh.	8
CLO3	Know and outline the fish response to different stimuli (such as light, sound etc.) and artificial lures.	3
CLO4	Describe and outline fish migration, fishing ground and fish detection.	4
CLO5	Describe and demonstrate fish harvesting systems.	4
CLO6	Describe and outline different harvesting methods.	4

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	**Introduction:** Principles and theories of fishing; modem trends in fishing, fishing regulations, types of fishing (industrial fishing, successful and unsuccessful fishing, responsible fishing, sports fishing, pelagic fishing, mesopelagic fishing, benthic fishing), fishing equipment other than nets (lamps, light, pumps etc.). **Fishery reconnaissance**: Location and detection of fish and shellfish, plankton monitoring, hydrographic observation, fishing crafts, Eco-sounding, infrared photography, SONAR, fish finder, low tight television, laser application, satellite investigation.	Lectures followed by discussion Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO2	**Fishing gears:** Classification, materials, terminology, numbering systems, characteristics of fishing twines, relative efficiencies of nets of different materials, preservation of net, net weaving and mending, knotless nets. **Fishing gears and their operation**: Trawling gears, seine nets, purse seine net, gill nets, trammel net, hooks and lines. **Fishing crafts:** Classification, common and technical terms for various parts of fishing craft, materials, Traditional and mechanized crafts of Bangladesh.	Lectures followed by discussion Participatory question-answer	
CLO3	**Manipulation of fish behaviour**: Fish response to stimuli; attraction and concentration (baits and ground bulls); frightening by artificial lures, light and sound.	Lectures followed by discussion Participatory question-answer	
CLO4	**Fishing grounds**: Fish migration and fishing. Pattern of a typical fishing ground. Selection of fishing grounds. Fish detection and luring methods. Exploitation of fishing grounds and their maintenance. Fishing grounds in the Bay of Bengal.	Lectures followed by discussion Participatory question-answer	
CLO5	**Aquaculture harvesting systems**: Fishing techniques, pond draining, drying, trapping, cast netting etc.	Lectures followed by discussion Participatory question-answer	
CLO6	**Methods of harvesting**: Demersal, Pelagic, shrimp harvesting; narcotising fishing, electrofishing, chemical fishing, without gears fishing, present status of fishing, problems of trash fishes.	Lectures followed by discussion Participatory question-answer	

Recommended literature:

1. Fish Catching Methods of the World (3rd edn). A. V. Brandt (1984). Fishing News (Books) Ltd. Surrey, England.
2. Modern Fishing Gears of the World. Vol. I-III. H. Kristyonsson (ed) (1962). Fishing News Books Ltd. London.
3. How to make and set nets. E. Garner (1962). Fishing News Books Ltd. London.
4. On Testing the Freshness of Frozen Fish. G. J. A. Peter (ed.) (1971). Fishing News Books Ltd. London.
5. Harvest and Post-harvest Technology of Fish. Rabindran((1985). Soc. Fish. Technol. India.
6. Industrial Fishery Technology. M. E. (1963). Reinhold Publ. Corp. New York.

7. Commercial Fishing Methods and Introduction to Vessels and Gears. J. C. Sainsbury (1975). Fishing News (Books) Ltd. London.

0831-2206: Biostatistics

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six 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 statistics and its scope, population and sample, variance and data, central tendency and its measures, probability, sampling, correlation and regression, and test of hypothesis. The course is designed to strengthen the student's existing knowledge of biostatistics and its classification and application to fisheries and aquaculture research. Additionally, this course covers basic understanding the goodness of fit and independence of two attributes in a contingency table, lest of significance of correlation coefficient and regression coefficient and its uses in fisheries and aquaculture research.

Learning Outcomes:

By the end of the course, students should be able to understand the- (i) importance and scope of the biostatistics, (ii) estimation of inferential and descriptive statistics, (iii) calculation of mean, mode, median, variance, standard deviation (iv) preliminary idea on sampling (v) estimation of correlation and regression and (vii) testing of hypothesis regarding population mean, and equality of two means.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Define the Statistics, Biostatistics and its classification and application to fisheries and aquaculture research. Know the data and variable and its frequency distributions and geographical representations.	6
CLO2	Describe the central tendency and its measurement; measures of dispersion and application in fisheries and aquaculture research.	4
CLO3	Know the elementary theory of probability, law of probability, probability distributions and uses of bimodal, poison and normal distributions.	3
CLO4	Describe the concept of statistical populations and samples, preliminary idea on sampling methods; definition and use of standardized normal variate, sampling and non-sampling errors.	3
CLO5	Estimate the Simple correlation, linear regression, useful theorem in correlation and regression, relationship between co-efficient of correlation and regression co-efficients, residual error, standard error of regression co-efficient and its application in fisheries and aquaculture research.	5
CLO6	Describe the Tests of hypothesis (type I and type II), errors and level of	7

CLOs	Course Learning Outcomes	Lectures
	significance, t-test, F-test, chi-square test and their applications; testing of hypothesis regarding population mean, equality of two means, population variation, equality of two population variances, goodness of fit and independence of two attributes in a contingency table, lest of significance of correlation coefficient and regression coefficient and its uses in fisheries and aquaculture research.	

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □, No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Definition and scope of statistics, discrete and continuous variables, classification, construction of frequency distribution and graphical representation of data.	Lectures followed by discussion Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	Central tendency and its measures- mean, median, mode, quartile; dispersion and its measures, moments, skewness and kurtosis.	Lectures followed by discussion Participatory question-answer	
CLO3	Elementary theory of probability, laws of probability, additive and multiplicative laws of probability and Bay's theorem, random variables, probability distribution, derivation; properties and uses of Binomial, Poisson and Normal distributions, Binomial, Poisson and Normal distribution of observed data.	Lectures followed by discussion Participatory question-answer Online resources	
CLO4	The concept of statistical populations and samples, preliminary idea on sampling methods; definition and use of standardized normal variate, sampling and non-sampling errors.	Lectures followed by discussion Participatory question-answer Online resources	
CLO5	Correlation and Regression: Simple correlation, linear regression, useful theorem in correlation and regression,	Lectures followed by discussion Participatory question-	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
	relationship between co-efficient of correlation and regression co-efficients, residual error, standard error of regression co-efficient.	answer Online resources	
CLO6	Tests of hypothesis (type I and type II), errors and level of significance, t-test, F--test, chi-square test and their applications; testing of hypothesis regarding population mean, equality of two means, population variation, equality of two population variances, goodness of fit and independence of two attributes in a contingency table, lest of significance of correlation coefficient and regression coefficient.	Lectures followed by discussion Participatory question-answer Online resources	

Recommended books/ literature:

1. Alder H (1977) *Introduction to Probability and Statistics, 6th edition*. WH Freeman, San Francisco.
2. Bancroft H (1957) *Introduction to Biostatistics*. Hoeber-Herper. New York.
3. Chatterjee S and Price B (1977) *Regression Analysis by Example*. John Wiley, New York.
4. Fisher RA (1956) *Statistical Methods and Scientific Inference*. Oliver, Edinburgh.
5. Goldstein A (1968) *Biostatistics An Introductory Text*. MacMillan, New York.
6. Gomez K and Gomez AA (1984) *Statistical Procedures for Agricultural Research, 2nd edition.* John Wiley and Sons. Inc., New York.
7. Goon AM, Gupta MK and Gupta D (1979) *Fundamentals of Statistical Theory Vol. 1, 2, 3*. World Press Pvt. Ltd., Calcutta, India.
8. Goulden GH (1952) *Methods of Statistical Analysis*. John Wiley, New York.
9. Johnson RR (1976) *Elementary Statistics*, *2nd edition*. Duxberg Press, Massachusetts.
10. Lewis A (1971) Biostatistics. East West Press, New Delhi.
11. Mostafa MG (2016) *Methods of Statistics, 2nd edition*. Brother's Publications, Dhaka.
12. Shil KN and Debnath SC (1992) *An Introduction to the Theory of Statistics, 2nd edition.* Sirajuddowalla Road, Chittagong.
13. Steel GD and Torric JH (1960) *Principles and Procedures of Statistics*. MacGraw Hill Book Co. Inc. New York.
14. Yule GU and Kendall MG (1965) *An Introduction to the Theory of Statistics*. Charles Griffin & Company Limited, London.
15. Zar JH (1999) *Biostatistical Analysis*. Prentice Hall, Upper Saddle River, N.J.

Practical Courses

0831-2211: Practical on Biological Limnology

Credit: 1
Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Identify and count of phytoplankton, zooplankton and benthos.	5
CLO2	Estimate of chlorophyll-*a* content in laboratory.	2
CLO3	Classify and describe of periphyton and higher aquatic plants	5

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Qualitative and quantitative study of phytoplankton, zooplankton, benthos.	- Lectures - Direct identification under microscope	**Full marks: 100** Attendance :10 Class record / Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Estimation of chlorophyll-*a* content.	- Lectures - Laboratory analysis	
CLO3	Qualitative study of periphyton and higher aquatic plants	- Lectures - Laboratory identification	

0831-2212: Practical on Fisheries Systematics

Credit: 1
Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Measure and analyze different morphometrics characteristics in fishes.	3
CLO2	Measure and analyze different meristics characteristics in fishes.	3

CLOs	Course Learning Outcomes	Lectures
CLO3	Apply different methods of taxonomic collection, preservation and labeling of fisheries specimen.	3
CLO4	Apply curation and cataloguing of collected specimen.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	●	X	X	X
CLO2	X	●	X	X	X
CLO3	X	●	X	X	X
CLO4	X	●	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Study of morphometrics characteristics in fishes.	- Observation - Characteristics analysis - Drawing	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Study of meristics characteristics in fishes.	- Demonstration - Characteristics analysis - Drawing	
CLO3	Study of taxonomic collection, preservation and labeling of fisheries specimen.	- Observation - Demonstration - Drawing	
CLO4	Study of curation and cataloguing of collected specimen.	- Demonstration - Documentary film show	

0831-2213: Practical on Freshwater Aquaculture

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Determine growth performance of fish in aquaculture pond.	2
CLO2	Calculate feed performance in aquaculture pond.	2
CLO3	Demonstrate land and water based aquaculture	3
CLO4	Identify and solve problem on aquaculture.	2
CLO5	Calculate the economics used in aquaculture such as CBR, BCR etc.	1
CLO6	Undergo field visit to different types of fish farming and report writing.	1

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Study of growth performances in aquaculture pond.	- Lecture - Field observation	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Study of feed performance in aquaculture pond.	- Lecture - Field observation	
CLO3	Method demonstration on land and water based aquaculture	- Lecture - Field observation	
CLO4	Identification of aquaculture problem through field visit.	- Lecture - Field observation	
CLO5	Economics used in aquaculture such as CBR, BCR etc.	- Lecture - Field observation	
CLO6	Field visit to different types of fish farming and report writing.	- Lecture - Field visit	

0831-2214: Practical on Aquaculture Nutrition

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Acquaint with nutritional laboratory equipment.	2
CLO2	Recognize available fish feed ingredient and their nutritional composition.	2
CLO3	Determine proximate composition of feed ingredients and compounded feed samples.	3
	Estimate growth and feed utilization parameters.	
CLO4	Measure digestibility of protein, lipid and carbohydrate.	1
CLO5	Estimate of calorific value of various food stuffs. Familiar with techniques of collection of faecal materials.	1
CLO6	Study on the nutritional disorders in fish.	1

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Introduction to nutritional laboratory equipment.	- Lectures - Problem solve	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Recognized available fish feed ingredient and their nutritional composition	- Lectures - Problem solve	
CLO3	Proximate analysis of feed ingredients and compounded feed samples: protein, ash and Crude fibre	- Lectures - Analyzing data	
CLO4	Digestibility studies of protein, lipid and carbohydrate using various external dietary markers such as, chromic oxide, silica, cellulose, etc.	- Lectures - Laboratory Experiment	
CLO5	Estimation of calorific value of various food stuffs by Bomb Calorimetry. Techniques of collection of faecal materials.	- Lectures - Laboratory Experiment	
CLO6	Estimation of growth and feed utilization parameters	- Lectures - Laboratory experiment	

0831-2215: Practical on Fishing Technology

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Identify fishing gears and its materials.	2
CLO3	Identify different fishing crafts of Bangladesh	2
CLO4	Know and identify net materials and their technique of preservation	3
CLO5	Recognize and distinguish fishing gears and nets	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Identification of fishing gears and its materials: traps, nets, hooks, spear etc.	- Lectures - Problem solve	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Identification of crafts: different types of boats, trowels, vassals etc. (hooks, nets and other) of Bangladesh.	- Lectures - Problem solve	
CLO3	Study of net materials, marketing and mending of nets, techniques of net preservation.	- Lectures - Laboratory experiment - Analyzing data	
CLO4	Field visit to observe operation of fishing gears and craft.	- Lectures - Laboratory Experiment	

0831-2216: Practical on Biostatistics

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Estimate the frequency distributions and its graphical representation and calculation of nations measures of central tendency and dispersion.	3
CLO2	Estimate mean, median and mode of data in relationship fisheries and aquaculture.	2
CLO3	Determine the population mean using samples in fisheries.	1
CLO4	Calculate the correlation coefficient and fitting simple linear regression to observed data. Estimate the testing hypothesis regarding population mean; testing the significance of simple correlation coefficient and regression coefficient (S);	3
CLO5	Calculate the chi-square for testing goodness of fit and test of independence of attributes in a contingency table.	2
CLO6	Apply the field layout analysis of variance and interpretation of data collected in completely randomized design randomized block design and Latin square design.	3

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □, No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Estimation of frequency distributions and its graphical representation and calculation of nations measures of central tendency and dispersion.	- Lectures - Analyzing data	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Estimation of mean, median and mode of data in relationship fisheries and aquaculture data.	- Lectures - Analyzing data	
CLO3	Determination of the population mean using samples in fisheries.	- Lectures - Analyzing data	
CLO4	Calculation of correlation coefficient and fitting simple linear regression to observed data. Testing the hypothesis regarding population mean; testing the significance of simple correlation coefficient and regression coefficient (S);	- Lectures - Laboratory Experiment	
CLO5	Calculation the chi-square for testing goodness of fit and test of independence of attributes in a contingency table.	- Lectures - Laboratory experiment	
CLO6	Application of field layout analysis of variance and interpretation of data collected in completely randomized design randomized block design and Latin square design.	- Lectures - Laboratory experiment	

Viva-voce Course

0831-2221: Viva-voce

Credit: 1
Full marks: 100

Course Learning Outcomes (CLOs):

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

CLOs	Course Learning Outcomes	Sessions
CLO1	Communicate and express verbally the knowledge obtained in an effective and clear manner on Fish Physiology, Molecular Biology and Histology, Fish Behaviour, Fish Nutrition, Parasitology, Fish Food Chemistry, Biological Limnology, Fisheries Systematics, Freshwater Aquaculture, Aquaculture Nutrition, Fishing Technology and Biostatistics.	12

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □, No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X

B. Sc. Fisheries (Honours) 3rd Year 1st Semester Examination, January-June 2026

Theoretical Courses

0831-3101: Coastal Aquaculture and Mariculture

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course to complete 4-year B. Sc. Fisheries (Honours) degree. The course introduces the basic concepts on various aspects of coastal aquaculture and mariculture. The course specially focuses on present status and problems of coastal aquaculture, aquaculture systems and kinds of aquaculture practices for fin fish, shell fish in coastal and marine area.This course also provides knowledge on estimate the resources available in Bangladesh to develop coastal aquaculture and mariculture, the areas available for culture of brackish water finfish, shellfish and seaweeds.

Learning Outcomes:

At the end of the course, the students will be able to: i) Know the definition of coastal aquaculture and mariculture and different aquaculture practices for coastal and marine; ii) estimate the resources available in Bangladesh to develop coastal aquaculture and mariculture, the areas available for culture of brackish water finfish, shellfish and seaweeds iii) Understand the insight of mangrove aquaculture and iv) produce pearl from pearl bearing oysters through operations.

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.	2
CLO3	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.	2
CLO4	Learn and practices of different culture techniques of marine fishes (mullet, seabass, milk fish etc.), shrimps and prawns, crabs, mussels, clams, oysters, abalone, scallop, squid, green turtle and sea-weeds. Mariculture techniques: Different systems of Cage culture and rope culture.	6

CLOs	Course Learning Outcomes	Lectures
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

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	**Introduction:** Definition, present status and problems of coastal aquaculture and mariculture in Bangladesh.	- Lectures followed by discussion - Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
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, seabass, milk fish etc.), shrimps and prawns, crabs, mussels, clams, oysters, abalone, scallop, squid, green turtle and sea-weeds. **Mariculture techniques:** Cage culture, rope culture etc.	- Lectures followed by discussion with PowerPoint presentation Participatory question-answer	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
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	

Recommended literature:

1. Aquaculture in Shallow seas: Progress in Shallow Sea Culture, T. Imai (1977), Oxford IBH Publ. Co., New Delhi, Bombay, Calcutta.
2. Aquaculture, J. E. Bardach, J. H. Ryther and W. O. Mclarney (1972), John Wiley and Sons. Inc., New York.
3. Coastal Aquaculture in the Indo-Pacific Region, T. V. R. Pillay (1973), Fishing News (Books) Ltd., London.
4. Coastal Environment and Shrimp Cultivation, A. K. M. Nuruzzaman (1993), BARC Farmgate, Dhaka.
5. CRC Hand Book of Mariculture, Vol. 1: Crustacean Aquaculture, J. McVey, J. Moore (1983).
6. CRC Hand Book of Mariculture, Vol. II: Finfish Aquaculture, J. McVey (1991).
7. Crustacean Farming, D. C. C. Lee and J. F. Wichins (1991), Oxford Fishing News Books/ Blackwell Sci. Publ. Ltd.
8. Prawn and Prawn Fisheries of India, C. V. Kurian and V. O. Sebastian (1976), Hindustan Publ. Co., New Delhi.
9. Problems in Prawn culture, K. Shigeno (1978), Amerind Publ. Co. Pvt. Ltd., New Delhi.
10. Recent Advances in Aquaculture, Vol. 2, J. F. Muir and R. J. Roberts (1985), Beckenham U. J. Croom Helm, London.
11. Recent Advances in Aquaculture, Vol. 3, J. F. Muir and R. J. Roberts (1988), Croom Helm, London.

0831-3102: Principle of Fish Genetics

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is designed to provide detailed understanding of the genetic basic mechanisms such as Mendelian laws, linkage, genotype frequency, mutation and multiple allelism. The topics also

include mechanism of sexuality, sex determination, sex-linked and sex-limited inheritance in fishes. Quantitative and qualitative genetics are discussed in-depth for stock improvement with better performances and to increase quantity and quality of finfish and ornamental aquaculture and fisheries management.

Learning Outcomes:

After completion of this course, the students will learn about inheritance of variation in quantitative and qualitative phenotypes and its application in aquaculture and ornamental fish culture.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe historical background of genetics and role of genetics in fisheries and aquaculture. Define genetical terminology. Explain and apply Mendelian laws. Exploit genetics of qualitative phenotypes (phenotypes produced by single autosomal gene or by two or more autosomal genes). Explain the genetics and patterns of inheritance of the special features of ornamental fish.	7
CLO2	Explain inheritance related to linkage with their types, theory, mechanism, factors and significance. Discuss and apply multiple allelism in fisheries and aquaculture.	2
CLO3	Explain different types of Mutation, mutagen and mutagenesis with their application in fish for fisheries and aquaculture	2
CLO4	Discuss and apply genetics of quantitative phenotypes (Phenotypic variance; genetic and environmental variance; genetic-environment interaction variance)	2
CLO5	Exploits inheritance associated with sex in fishes (Sexuality; Sex determination; sex-linked and sex-limited inheritances).	5
CLO6	Understand the Genetic principles in relation to fish populations. Understand the genetic basis of domestication in fishes.	4

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Introduction: Historical background of genetics and genetical terminology; role of genetics in aquaculture. Mendelian genetics: Mendelian law and deviation of mendelism. Genetics of qualitative phenotypes: Phenotypes produced by single autosomal gene (complete dominant gene action, incomplete dominant gene action, additive gene action); Phenotypes produced by two or more autosomal genes (epistatic gene action, non-epistatic gene action). The genetics and pattern of inheritance of the special features of ornamental fish.	- Lectures followed by discussion - Participatory question-answer	**Total (100)** **Attendance: 10** **In course Examination/ Tutorial/Quiz/ Class Test: 20** **Final Examination: 70**
CLO2	Linkage: Definition, types, theory, mechanism factors and significance. Multiple allelism: Definition, properties, examples.	- Lectures followed by discussion - Online resources	
CLO3	Mutation: Definition, types, gene mutation and chromosomal mutation, metagene, importance of mutation; Uses of mutation in fish	- Lectures followed by discussion - Online resources	
CLO4	Genetics of quantitative phenotypes: Phenotypic variance; genetic and environmental variance; genetic-environment interaction variance.	- Lectures followed by discussion - Participatory question-answer	
CLO5	Inheritance associated with sex: Sexuality; Sex determination; sex-linked and sex-limited inheritances in fishes.	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO6	Population Genetics and domestications in fish: Definition; Hardy-Weinberg law; gene and genotype frequency; forces of change in gene frequency; small populations; consequence of genetic drift and sampling; description of domestication levels in fish species; characteristics of domesticated fish species; strategies and obstacles of domestication in fish.	- Lectures followed by discussion - Participatory question-answer - Online resources	

Recommended literature:

1. Genetics for fish hatchery manager. D. Tave, 1993. 2nd ed. Van Nostrand Reinhold, New York.
2. An introduction to quantitative genetics. D. S. Falconer, 1996.
3. Genetics. Strickberger, M. W. 1985. Prentice-Hall of India Pvt. Ltd. New Delhi-110001.
4. Principles of Genetics. Tamarin, R. H. 1999. McGraw Hill Inc. Book Co. New York, San Francisco, Toronto, London.
5. Biology of the Gene. Levine, L. 1980. The C. V. Mosby Company, St. Louis / Toronto / London.
6. Introduction to Genetic Analysis. Griffiths, J. F., Miller, J. H., Suzuki, D. T., Lewontin, R. C., Gelbart, W. M. 1998. W. H. Freeman and Company. New York.
7. The Principles of Heredity. Synder, L. H. and David, P. R. 1957. D. C. Health and Company, Boston.
8. Genetics. Verma, P. S. and Agarwal, V. K. 1975. S. Chand and Company Ltd., Ram Nagar, New Delhi-110055.
9. Fundamentals of Genetics. Sing, B. D. 2000. Kalyani Publishers, New Delhi.

0831-3103: Fish Pathology and Immunology

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete 4-year B. Sc. in Fisheries (Honours) 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/immunity against 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) Understand the immune system and mechanisms immunological responses of fish.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Define fish pathology, pathogen, disease andepizootiology; describe the importance of pathology and types of pathogen, explain the factors responsible for disease, general symptoms and pathological changes of	4

CLOs	Course Learning Outcomes	Lectures
	diseased fish; define stress; describe the symptoms, responsible factors and effect of stress; understand the role of stress to produce disease	
CLO2	Define infection and deference mechanism; understand the infection types and process and host-pathogen interactions; define pathogenicity and pathogenesis; understand the mechanism of microbial pathogenicity and pathogenesis	5
CLO3	Describe the infectious disease (fungal, bacterial and viral) in fish and shrimp; describe the environmental, nutritional, hereditary disease in fish and shrimp	5
CLO4	Define of immunology and immunity; describe the importance of immunology and immune functions of blood cells (phagocytes, lymphocytes and thromocytes)	4
CLO5	Explain the types and mechanism of non-specific and specific immunity of fish; Define immunization; understand the types and techniques of immunization	4
CLO6	Define antigen and antibody; describe the types, functions and structure of antigen and antibody; understand the antigenicity and immunogenicity;	4

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	**Introduction:** Definition of fish pathology, pathogen, disease andepizootiology; importance of pathology and types of pathogen, factors responsible for disease, general symptoms and pathological changes of diseased fish; definition of stress; symptoms, responsible factors and effect of stress; role of stress to produce disease	- Lectures followed by discussion - Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	**Infection, defense and pathogenicity:** Definition of infection and deference mechanism; infection types and process	- Lectures followed by discussion - Online resources	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
	and host-pathogen interactions; Definition of pathogenicity and pathogenesis; mechanism of microbial pathogenicity and pathogenesis		
CLO3	**Infectious and non infectous disease:** Common infectious disease (fungal, bacterial and viral) in fish and shrimp; common Environmental, nutritional, hereditary disease in fish and shrimp	- Lectures followed by discussion - Online resources	
CLO4	**Introduction of immunology:** Definition of immunology and immunity; the importance of immunology, immune functions of blood cells (phagocyts, lymphocytes and thromocytes)	- Lectures followed by discussion - Online resources	
CLO5	**Immunity of fish:** Types and mechanism of non-specific and specific immunity of fish; definition, types and techniques of immunization	- Lectures followed by discussion - Video demonstration	
CLO6	**Antigen and antibody:** Definition of antigen and antibody; types, functions and structure of antigen and antibody; antigenicity and immunogenicity	- Lectures followed by discussion - Online resources	

Recommended 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.

0831-3104: Fisheries Post-Harvest Handling and Preservation

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is an applied theoretical course and prerequisite to complete 4-year B. Sc. in Fisheries (Honours) degree. The course covers the general principles of food preservation, commercial handling of fish and shellfish, value addition of wet fish, packaging, planning and design of fish processing plant. The course is designed to strengthen the student's knowledge on fisheries post-harvest handling and preservation. This course can also teach them the good practice of fish handling and post-harvest losses. In addition, this course also focuses on the fish working premises.

Learning Outcomes:

At the end of the course, the students will be able to-i) Know the commercial handling process of fish and shellfish ii) Explain the fish working premises and , planning and design of fish processing plant iii) Understand the value addition and packaging of wet fish.

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

CLOs	**Course Learning Outcomes**	**Lectures**
CLO1	States principles of fish preservation; identify the reasons of post-harvest losses of fish at different stages and recognize the nature of loss.	3
CLO2	Apply good practices in handling of fish raw materials and their bulk preservation and transportation, handling on board and off shore plant.	3
CLO3	Describe the chilling methods; explain the preservative effects of chilling in fish& shellfish; explain the factors affecting the quality of fish & shellfish during chilling;	
CLO4	Define and briefly describe the value addition processes of wet fish including Skinning, beheading, gutting, dressed fish, fish chunk, fish fillet, mince, boned fish, boneless fish, fish steak, fish loins, shashimi, etc.	3
CLO5	Describe and distinguish the fish working premises. Design and plan of fish cold storage and processing plant.	3
CLO6	Describe the fish and shellfish packaging techniques. Packaging materials, wholesale packaging, traditional packaging, retail packaging, airfreight packaging, vacuum and modified atmosphere packaging.	3

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	States principles of fish preservation; identify the reasons of post-harvest losses of fish at different stages and recognize the nature of loss.	Lectures followed by discussion Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	Apply good practices in handling of fish raw materials and their bulk preservation and transportation.	Lectures followed by discussion Participatory question-answer Online resources	
CLO3	Chilling: Describe the chilling methods; explain the preservative effects of chilling in fish& shellfish; explain the factors affecting the quality of fish & shellfish during chilling.	Lectures followed by discussion Participatory question-answer Online resources	
CLO4	Define and briefly describe the value addition processes of wet fish including Skinning, beheading, gutting, dressed fish, fish chunk, fish fillet, mince, boned fish, boneless fish, fish steak, fish loins, shashimi, etc.	Lectures followed by discussion Participatory question-answer Online resources	
CLO4	Describe and distinguish the fish working premises; Design and plan of fish cold storage and processing plant.	Lectures followed by discussion Participatory question-answer Online resources	
CLO5	Design and plan of fish cold storage and processing plant.	Lectures followed by discussion Participatory question-answer Online resources	
CLO6	Describe the fresh fish packaging techniques such as modern packaging materials, wholesale packaging, traditional packaging, retail packaging, airfreight packaging.	Lectures followed by discussion Participatory question-answer Online resources	

Recommended literature:

1. Fish Processing Technology. T. K. Govinda (1985). Oxford and IBH Publi. Co., New Delhi.
2. Post-harvest Technology of Fish and Fish Products. Balachandran, K. K. 2001. Daya Publishing House, Delhi – 110035. India. 440 pp.
3. Fish Handling, Preservation and Processing in the Tropics. Part I and II. I. J. Clusas (editor). (1985). Tropical Development and Research Institute, London.
4. Processing of Aquatic Food Products. F. W. Wheaton and T. B. Lawson (1985). Wiley Inter Science, New York.
5. The Technology of Fish Utilization. K. Krenzer (1965). Fishing News (Books) Ltd. London.
6. The Freezing Preservation of Foods, Donald (editor). (1963). TheAviPubli. Co., Inc.
7. Preservation of Fish Products by Refrigeration. V. P. Zaitsev (1962). U. S. Department of Commerce.
8. Fish processing Technology. T. K. Govindan (1985). Oxford and IBH Publishing Co. Pvt. Ltd. (New Delhi, Bombay, Calcutta).
9. Advances in Fish Processing Technology by D. P. Sen. Sunil Sachdev. Allied Publishing Pvt. Ltd., New Delhi.
10. Participatory Training of Trainers: A New Approach Applied in Fish Processing by Dr. A. K. M. Nowsad Alam, 2007. Bangladesh Fisheries Research Forum (BFRF).

0831-3105: Oceanography

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete 4-year B. Sc. in Fisheries (Honours) degree. The course covers the different physical, chemical and biological characteristics and features of marine environment. The course is designed to strengthen the student's existing knowledge on oceanography and marine biology. This course can also teach them about chemical properties of sea water, topography of ocean bottom, tides, waves & current of seas water, sediment and pollution of marine environment. A number of further topics, like coastal upwelling, fisheries oceanography will be also focused in the course.

Learning Outcomes:

After completion of this course, the students will learn about chemical properties of sea water, topography of ocean bottom, tides, waves & current of seas water, sediment and pollution of marine environment.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Understand and explain the importance of oceanography and topography of ocean bottom. Describe international convention on sea and exclusive economic zone (EEZ) of Bay of Bengal. Discuss about physical and chemical properties of sea water.	7
CLO2	Explain about sources of marine pollution and causes of pollution in Bay of Bengal	3
CLO3	Describe sources, importance, transportation of marine sediment and factors influencing marine sediments.	2
CLO4	Explain role of tides and current in marine organisms and coastal upwelling system	3
CLO5	Discuss about food chain and food webs in marine ecosystem	2
CLO6	Explain how fisheries oceanographic knowledge help fishermen in commercial fishing in ocean	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	**Introduction:** Definition of oceanography, ocean and sea; importance of the ocean and oceanography; history and study topics of oceanography; description of the world ocean; topography of the ocean bottom; marine environment (classification and description of major marine habitats). International convention on sea, Exclusive economic zone (EEZ) of Bay of Bengal. Physico-chemical properties of sea water: Temperature, light, salinity, dissolved gases and major nutrients	Lectures followed by discussion Participatory question-answer Online resources	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	**Marine pollution:** Definition and sources of marine pollution, pollution in coastal region and vulnerability to increasing pollution level, abetment or management of pollution.	Lectures followed by discussion Participatory question-answer	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO3	**Oceanic sediment:** Definition, importance, sources, classification; transportation, distribution and arrangement of oceanic sediments; influencing factors.	Lectures followed by discussion Participatory question-answer Online resources	
CLO4	**Oceanic tides, waves and currents:** Definition, type and role of tide on marine organisms; definition, structure of wave, coastal upwelling and eddy diffusion; definition, role of current on marine organisms, factors influencing currents in the ocean.	Lectures followed by discussion Participatory question-answer Videos	
CLO5	**Marine food chain and webs:** Food chain and webs in marine ecosystem, marine fisheries food webs.	Lectures followed by discussion Participatory question-answer	
CLO6	**Fisheries oceanography:** Definition of fisheries oceanography; utilization of oceanographic knowledge in locating new fishing grounds, identification and location of unused fishery resources, information for improving fishing tactics and fishery forecasting.	Lectures followed by discussion Participatory question-answer	

Recommended literature:

1. Climate and Fisheries. D. H. Cushing
2. Marine Climate, Weather and Fisheries. T. Laevastu.
3. Climatology. D.S. Lal.
4. Foundation of Climatology. E.T. Stringer.
5. An Introduction to physical oceanography. W. Von Arx.
6. Principles of oceanography. A. R. Davis.
7. Geochemistry of sediments. E. T. Degens.
8. Chemical Oceanography. R. Lange.

0831-3106: Rural Sociology and Fisheries Economics

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

The course covers various aspects of Rural Sociology such as social structure, social stratification, social mobility, social changes and socioeconomic condition of fish farmers. The purpose of this course is to identify the social status and problems and can give need based recommendation as

well as take necessary steps for the fishermen or fish farmer according to their social status. It will also covers economic issues in any venture, especially in agriculture and fisheries. In addition to theories of economics, real-life examples from the fisheries sector would enable students to better understand the underlying theories and principles of economics.

Learning Outcomes:

At the end of the course the students will be able to identify the social and economic status and problems and can give need based recommendation as well as take necessary steps for the fishermen or fish farmer according to their social status.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe definition, history and importance of sociology and rural sociology and terminologies. Define and compare rural and urban sociology	2
CLO2	Define and outline elements, types, slavery, estates castes, class and status. Describe different types of social mobility. Describe social changes and its governing factors.	2
CLO3	Know and outline about the socio-economic conditions of the fishermen. Know and describe about rural development.	2
CLO4	Understand and explain basics of economics; its nature and methodology; and theories	4
CLO5	Identify potential credit sources in fisheries, donor and other economic and associated organisations	4
CLO6	Know and calculate economic analysis of various fisheries venture	6

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □, No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	**Introduction:** Definition of sociology and rural sociology; historical background and importance of rural sociology; primary concept of society, community, culture and group; factors influencing social life **Social structure:** Comparative study of rural and urban sociology	- Lectures followed by discussion - Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO2	**Social stratification:** Elements, types, slavery, estates castes class and status. **Social mobility:** Reasons, types, horizontal, vertical and geographical mobility **Social changes:** Factors involved	- Lectures followed by discussion - Participatory question-answer	Examination: 70
CLO3	Socio-economic conditions of the fishermen. Rural development.	- Lectures followed by discussion - Participatory question-answer	
CLO4	**Introduction to fisheries economics:** Basic definitions, scope and methods, partial and general equilibrium analysis, macro and micro economics. Supply and demand: Definitions, utility analysis of demand, law of diminishing marginal utility, indifference curve, elasticity of supply and demand, law of supply and demand, consumer's surplus. Applications in fisheries. Theory of production: Factors of production, scale of production, production possibility curve and production function, laws of returns, isoquants or equal product curves, cost and cost curves, market and market structure National income: Meaning, concepts and basic definitions; measurement of national income; difficulties in measurement; significance of national income statistics.	- Lectures followed by discussion - Participatory question-answer	
CLO5	Financing in fisheries: Money, banking, credit, micro-credit and fisheries.	- Lecture - Literature screening	
CLO6	Economic analysis in fish culture: Basic concepts and important definitions, steps in fish farm planning, cost benefit ratio, economic problems, farm profitability analysis, economic analysis of different fish farming techniques.	- Lecture - Economic calculation	

Recommended literature:

1. Dewett KK (1946) Modern economic theory. Shyam Lal Charitable Trust, Ram Nagar, New Delhi, India.
2. An Introduction to Economics for Students of Agriculture. B. Hill (1980). Pergamen Press, London.
3. The Economics of Natural Resources. R. Lecomber (1979). MacMillan, London.

4. Small Scale Fisheries in Asia: Socio-economic Analysis and Policy. T. Panayotou (1987). Idrc-229c. Canada.
5. Resources Economics: An Economic Approach 10 Natural Resources Environmental Policy. A. Randal. (1987). Wiley, New York.
6. Aquaculture Economics: Basic Concepts and Methods of Analysis. Y. C. Shang. (1981). Westview Press, London.
7. Economics (13th edn.). P. A. Samuelson and W. D. Nordhaus (1989). McGraw Hill, New York.
8. Food from the Sea: The Economics and Policies of Ocean Fisheries. F. W. Bell. (1978). Westview Press, London.**:**
9. Sociology. S. Koeig (1957). Barnes and Noble Inc. New York.
10. Foundation of Modem Sociology. M. Spencer. (1981). Prentice Halt. Canada.
11. Sociology. P. B. Horton and C. L. Hunt. (1964). McGraw Hill Inc. Book Co. New York, San Francisco, Toronto, London.
12. Small Scale Fisheries in Asia: Socio-economic Analysis and Policy. T. Panayotou (1987). Idrc-229c. Canada.

0831-3111: Practical on Coastal Aquaculture and Mariculture

Credit: 1
Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	**Course Learning Outcomes**	**Lectures**
CLO1	Identify the commercially important fishes and shellfish, sea weeds of coastal area with its new approach to aquaculture.	3
CLO2	Learn different culture systems of artemia, rotifers, seal algae and others important zooplankton etc. in laboratory.	3
CLO3	Demonstrate different models of Culture techniques of oyster, mussels, clams and seaweeds.	3
CLO4	Achieve practical experience on different aquaculture techniques in coastal and marine areas.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	**PLOs**				
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Collection and identification of commercially important fishes and shellfish, sea weeds of coastal area with special reference to new approach to aquaculture.	-Lectures -Model demonstration	**Full marks:100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Laboratory culture of artemia, rotifers, seal algae and others important zooplankton etc.	-Lectures -Laboratory analysis	
CLO3	Culture techniques of oyster, mussels, clams and seaweeds.	-Lectures -Field visit	
CLO4	Field visit to study on different aquaculture techniques practiced in coastal and marine areas.	-Lectures -Field visit	

0831-3112: Practical on Principle of Fish Genetics

Credit: 1
Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Compute and analyze results of monohybrid crosses	2
CLO2	Compute and analyze results of dihybrid crosses	2
CLO3	Familiarization with starch gel Electrophoresis techniques and analyze gene and genotype frequency data from allozyme data	2
CLO4	Perform Extraction of Genomic DNA from fish tissue	2
CLO5	Perform chromosomal preparation for karyological study of fishes.	2
CLO6	Understand and apply DNA barcoding system	1

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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**

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Statistical Methods for analysis of results of monohybrid genetic crosses	- Lectures - Problem solve	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Statistical methods for analysis of results of monohybrid genetic crosses	- Lectures - Problem solve	
CLO3	Electrophoresis techniques	- Lectures - Laboratory experiment - Analyzing data	
CLO4	Extraction of Genomic DNA from fish tissue	- Lectures - Laboratory Experiment	
CLO5	Karyology of fishes: Methods of chromosome preparation in fishes.	- Lectures - Laboratory Experiment	
CLO6	DNA bar coding system	- Lectures - Laboratory experiment	

0831-3113: Practical on Fish Pathology and Immunology

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Perform filed observation of general symptoms of diseased fish	2
CLO2	Perform laboratory observation of pathological changes in different organs in diseased fish	2
CLO3	Exploit microbial pathogens and the diseased caused by them	2
CLO4	Perform collection and identification techniques of pathogens from infected fish	2
CLO5	Perform immunological technique to identify microbial pathogen	2
CLO6	Field observation of diseased fish from fish farm, hatchery, fish ponds.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Perform filed observation of general symptoms of diseased fish	- Lectures followed by discussion - Field observation	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Perform laboratory observation of pathological changes in different organs in diseased fish	- Lectures followed by discussion - Laboratory observation	
CLO3	Exploit microbial pathogens and the diseased caused by them	- Lectures followed by discussion - Slide show	
CLO4	Perform collection and identification techniques of pathogens from infected fish	- Lectures followed by discussion - Laboratory experiments	
CLO5	Perform immunological technique to identify microbial pathogen	- Lectures followed by discussion - Laboratory exercise	
CLO6	Field observation of diseased fish from fish farm, hatchery, fish ponds.	- Interview, direct observation and discussion	

0831-3114: Practical on Fisheries Post-Harvest Handling and Preservation

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe the fish-processing laboratory; and explain the safety use of lab equipment, glass wares and chemicals.	3
CLO2	Perform value addition for wet fish.	2
CLO3	Describe different types of processing and dressing patterns for exportable prawn	3

CLOs	Course Learning Outcomes	Lectures
CLO4	Visit fish preservation facilities in local fish markets	3
CLO5	Describe the design and plan of fish cold storage and processing plant	2
CLO6	Perform vacuum and modified atmosphere packaging of fish and fishery products	3

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Acquaintance with fish processing laboratory and safety use of lab equipment, glasswares and chemicals.	- Lectures - Experiment	**Full marks: 100** Attendance : 10 Class record/Report:30 Practical: 60 Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.) Viva-voce: 20
CLO2	Preparation of wet fish for value addition	- Lectures - Laboratory	
CLO3	Types of ice and ice markets.	- Lectures - Laboratory	
CLO4	Preparation of processing and dressing of frozen shrimp	- Lectures - Laboratory	
CLO5	Packaging: Function of packaging, package selection, packaging materials, packaging regulations, future of packaging. Modem approaches to fish processing: Vacuum and Modified atmosphere packaging, Sausvide technology in fish processing	- Lectures - Laboratory - Experiment	
CLO6	Design and planning of a fish processing plant.	- Lectures -Laboratory	

0831-3115: Practical on Oceanography

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe the position of oceans in world map	2
CLO2	Perform the zonation model of marine environment	2
CLO3	Measure and describe physic-chemical properties of sea water	2
CLO4	Identify and explain different groups of marine plankton available in marine environment	3

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Study of the world ocean, sea and bays special reference to Bangladesh	- Lectures - Demonstration of -- World map	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Preparation of zonation model of marine environment	- Lectures - Problem solve	
CLO3	Measurements of different physico-chemical properties of sea waters including tides, waves and currents.	- Lectures - Laboratory analysis	
CLO4	Study on marine plankton. Field visit and report preparation on different physic-chemical properties of sea water sample and collection of marine plankton sample from sea water.	- Lectures - Direct identification under microscope	

0831-3116: Practical on Rural Sociology and Fisheries Economics

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Conduct field surveys to know the socio-economic conditions of various stakeholder groups in fisheries sector.	3
CLO2	Determine economic issues of fish culture and can calculate expenditure and income issues.	2
CLO3	Design plans for any fisheries industries (e.g. fish processing plant, feed mill, fish hatchery etc.)	2
CLO4	Identify economic problems in Bangladesh and recommend solutions	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X

Lesson plan

CLOs	Course contents	Teaching strategy	Assessment Strategy
CLO1	Study of survey methods, development of questionnaire, pre-testing of survey questionnaire and basic techniques of data collections.	• Lectures • Field visits • Question and answer	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Study of cost and income issues in aquaculture, cost-benefit analysis	• Lectures • Field visit • Question and answer	
CLO3	Study of basics of entrepreneurship, factors affecting designing a fish processing plant, fish hatchery, feed mill etc.	• Lectures • Literature survey • Field visit • Question and answer	
CLO4	Identification of economic problems of different fisheries stakeholder groups and potential solutions to the problems	• Lectures • Literature survey • Field visit	

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0831-3201: Fish Hatchery Management

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course to complete 4-year B. Sc. Fisheries (Honours) degree. The course introduces the basic concepts on various aspects of hatchery techniques and management systems. The course specially focuses on hatchery components, breeding techniques of various freshwater fishes and brood stock management. This course also provides knowledge on feeding of early stage of fish and prawn, nursery rearing of fish and prawn along with live transportation systems. Finally, the course teaches how to produce fresh and marine water fish seed, which are vital educational concepts for a career as fish hatchery manager.

Learning Outcomes:

At the end of the course, the students will be able to- i) explain different structural components of fish hatcheries ii) skilled enough to operate a fish hatchery iii) apply hatchery techniques to produce quality seed iv) solve and minimize the problems during handling of fry and brood fish. At the end of the course, the students will able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Understand the importance and scope of fish hatcheries in Bangladesh.	1
CLO2	Explain the structural features of a fish hatchery.	3
CLO3	Explain different hatchery techniques used in natural and artificial breeding of fish.	4
CLO4	Apply knowledge in operating a fish farm and able to produce quality fish seed.	6
CLO5	Explain and demonstrate the pre-stocking, stocking and post-stocking management of brood fish pond, carp nursery, freshwater prawn nursery management in pond, hapa and cemented tank etc.	8
CLO6	Describe and demonstrate the transportation of live fry and fingerlings and adult fishes and antiseptics used during transportation.	6

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	**Introduction:** Definition, scope and importance of fish hatcheries; present status and existing problems in Bangladesh.	-Lecture -Power point presentation	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	**Hatchery components:** Structural features, incubators, essential components; water (supply, monitoring and treatment).	-Lectures followed by discussion -Participatory question-answer -Power point presentation	
CLO3	**Hatchery techniques:** Natural and artificial breeding, history of Induced breeding, inducing agents; baseline techniques for induced breeding (identification of mature fish, hormone treatment, natural and artificial spawning methods, control of spawning time, egg incubation, factors effecting egg development.	-Lectures followed by discussion -Participatory question-answer -Power point presentation -Online resources	
CLO4	**Fish Breeding:** Breeding techniques for native, Indian major carps, Chinese and common carps, catfishes and other commercially important fishes of Bangladesh.		
CLO5	**Fry and Brood fish management:** Pre-stocking (eradication and control of aquatic weeds and algae, unwanted fishes, predatory insects; fertilization of pond); Stocking (stocking of nursery ponds, rearing ponds and grow-out ponds; methods of stocking); and Post-stocking (feeding, periodic fertilization, pond environment monitoring, fish health and hazard monitoring) management.	-Lectures followed by discussion -Participatory question-answer -Power point presentation	
CLO6	**Transportation of live fry and fingerlings and adult fishes:** Equipment, water quality, handling, loading and stocking, shipping, use of anesthetics and antiseptics during transportation.	-Lectures followed by discussion -Participatory question-answer	

Recommended literature:

1. Text Book of Fish Culture: Breeding and Cultivation of Fish, M. Huet (1979). Chapter 1. Fishing News Books Ltd. Surrey, England.
2. Aquaculture Engineering. F. W. Wheaton (1987). Robert E. Krieger Pnbl., Florida.
3. Elementary Guide to Fish Culture in Nepal. E. Woynarovitch (1975). FAO, Rome.
4. Fish Culture. C. F. Hickling (1962). Faber and Faber, London.
5. A Hatchery Manual for the Common, Chinese and Indian Major Carps. V. G. Jhingran, R. S. V. Pullin (1985). Asian Development Bank and International Centre for Living Aquatic Resources Management, Manila, Philippines.
6. Shrimp Hatchery Manual, A. B. Al-Hajj and A. S. D. Farmer (1984). SafutKuwit Institute for Scientific Research 85p.
7. A Guide to Shrimp and Prawn Hatchery Techniques in Bangladesh. BAFRU (1990). Bafru/ Inst. of Aquaculture. Stirling, Scotland.
8. Marine Shrimp Culture: Principles and Practices. A. W. Fast and L. J. Lester (1992).
9. Proc. of the SAARC workshop on fish seed production- FRI. 11-12 June 1989.
10. Fish hatchery Management. R. G. Riper. I. B. McElwain. L. E. Orme, J. P. McCraren, L. G. Fowler and J. R. Leonard (1982). US Dept. of Interior Fish Wildlife Service, Washington D.C.
11. The Artificial Propagation of Warm water flit fishes manual for Extension. E. Waynarovich and L. Horvath (1980), FAO.

0831-3202: Fish Population Dynamics

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six 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 fish population and its scope and application in fisheries science. The course is designed to strengthen the student's existing knowledge of population parameters including growth, reproduction, recruitment and mortality of fishes and application to fisheries research. Additionally, this course covers basic understanding the condition factors, relationships between length-weight, age-length, marking and tagging techniques, migration and life history patterns of fishes.

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.

After finishing this 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. Also, estimate the Distribution and abundance and to know it's affecting factors	4
CLO2	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. Also, 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 analysis.	7
CLO3	Describe the timing of reproduction, length & age at sexual maturity, frequency of spawning, and fecundity and its application in fisheries management. Also, Know the timing of recruitment, length & age at recruitment, factors affecting recruitment and stock-recruitment relationships.	4
CLO4	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.	4
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.). Also, Describe the types, materials and duration of tags and marks, principles and techniques of tagging and marking and its application of fisheries research.	5
CLO6	Know the life history patterns and strategy of fishes and environment effects to stock density, and also to get the concept of r- and k- selection of species.	4

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Introduction: Importance and definition of different terminologies, salient features of population. 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	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	Size relationships and gear selectivity: Linear regression, length-length and length-weight relationships, and condition of fish populations; gear selectivity by covered codend& alternate haul experiments, gill net selectivity. Growth: 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 & computer-based analyses.	Lectures followed by discussion Participatory question-answer Online resources	
CLO3	Reproduction: Definition, timing of reproduction, length & age at sexual maturity, frequency of spawning, fecundity. Also, recruitment: Definition, timing of recruitment, length & age at recruitment, factors affecting recruitment and stock-recruitment	Lectures followed by discussion Participatory question-answer Online resources Video demonstration	
CLO4	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	
CLO5	Migration: Definition, Causes of migration, types of migration, migratory circuit of fishes, migration of some important commercially important fishes (Hilsha, herring, cod etc.). Also, 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	
CLO6	Life history patterns: Species life history strategy and its environment, effects related to stock density, concept of r- and k- selection of species, Bet-hedging.	Lectures followed by discussion Participatory question-answer	

Recommended literature:

1. Cushing, D.H., 1968. Fisheries Biology: A study in population dynamics. Univ. Wisconsin, Madison, USA. 200 pp.
2. Cushing, D.H., 1977. Science and the Fisheries. Edward Arnold Publishers Ltd. 25, Hill Street, London WIX 8LL. 60 pp.
3. Gulland, J.A. (ed.), 1988. Fish Population Dynamics. Second edition. John Wiley & Sons, Inc., New York.
4. King, M., 1995. Fisheries Biology, Assessment and Management. Fishing News Books, 342 p.
5. Lagler, K.F., 1956. Freshwater Biology, Second edition, William C. Brown Co. Dubuque, Iowa. 421 pp.
6. Nielsen, L.A., 1992. Method of Marking Fish and Shellfish. American Fish. Soc., Special Publication 23, 208 p.
7. Nikolskii, G.V., 1982. Theory of fish population dynamics. Bishen Singh, Mahendra Pal Singh and Otto Koeltz, Sci. Publishers, 323 pp.
8. Pauly, D., 1984. Fish population dynamics in tropical waters. A manual for use with programmable calculators. ICLARM, Manila, 325 p.
9. Ricker, W.E., 1968. Methos of assessment of fish production in freshwaters. Blackwell Scientific Publications, Oxford, 321 pp.
10. Solomon, M.E. 1976. Population dynamics. Second edition, Arnold (Publishers) Ltd. 67 p.
11. Rounsefell, G.A. and Everhart, W.H., 1953. Fishery Science: Its methods and application. John Wiley & Sons, Inc., New York. 444 pp.

0831-3203: Fish Feed Technology

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and condition to complete B. Sc. in Fisheries (Honours) degree with 8 semesters. The course deals with different types of fish feed and their importance and to identify indigenous sources of plant and animal origin ingredients with their proximate composition and available live feeds in aquaculture. Fish requires different types of feed based on the nutritional requirement of culturable fish. So, the central focus throughout the course is the feed selection, formulation and presentation of feed in intensive and semi-intensive culture system. This course will attempt to provide feeding method and basic rules of feeding rate and frequency for optimization of feeding cost in aquaculture. This course also creates an awareness about the manipulation of artificial feed and their impact on environment.

Learning Outcomes:

At the end of the course, the students will be able to about the fish feed ingredient of different sources, non-conventional feed, feed formulation, feeding methods, feeding rate and their application in fish ponds.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Know the fish feed ingredients and their importance. Know and distinguish the plant and animal origin ingredients for fish feed and their proximate composition.	2
CLO2	Know the non-conventional fish protein sources such as fish silage, fish meal, micro-encapsulated diets etc.	6
CLO3	Discuss on the Live feeds like *Tubifex*, *Artemia*, *Daphnia*, *Moina*, rotifers etc.	2
CLO4	Calculate and analysis using different Fish Feed Formulation methods based on nutritional requirements of various culturable fish species by the use of Pearson's square method and also analysis of 'best buy' based on protein and energy.	6
CLO5	Know how to Select the supplementary feeds and apply supplementary diet feeding techniques. Apply different Feeding methods such as Broadcasting, feeder, demand and non-demand feeders, feed particles shape and size	6
CLO6	know different Types of fish feed with their classification based on the stage of life cycle, Product quality fish feed. know and apply the Feeding rate and feeding frequency and practice of feeding in aquaculture including Basic rules of feeding frequency, Effect of environmental factors on feeding.	6

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	An introduction to Fish Feed and their importance and advantage in intensive and semi-intensive aquaculture.	- Lectures followed by discussion - Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO1	**Fish Feed stuffs:** Sources of plant and animal origin ingredients for fish feed and their proximate composition.	- Lectures followed by discussion - Participatory question-answer	
CLO2	**Non-conventional fish protein sources:** Fish silage, fish meal, micro-encapsulated diets etc.	- Lectures followed by discussion - Participatory question-answer	
CLO3	**Live feeds:** *Tubifex*, *Artemia*, *Daphnia*, *Moina*, rotifers etc.	- Lectures followed by discussion - Participatory question-answer	
CLO4	**Fish Feed Formulation:** Formulation of feeds based on nutritional requirements of various culturable fish species by the use of pearsons square method, analysis of 'best buy' based on protein and energy.	- Lectures followed by discussion - Participatory question-answer	
CLO5	**Supplementary feed:** Selection of supplementary feeds, Supplementary diet feeding techniques.	- Lectures followed by discussion - Participatory question-answer	
CLO5	**Feeding methods:** Broadcasting, feeder, demand and non-demand feeders, feed particles shape and size.	- Lectures followed by discussion - Participatory question-answer	
CLO6	**Type of fish feed:** Classification based on the stage of life cycle, Product quality fish feed.	- Lectures followed by discussion - Participatory question-answer	
CLO6	**Feeding rate and feeding frequency**, Practice of feeding in aquaculture, Basic rules of feeding frequency, Effect of environmental factors on feeding.	- Lectures followed by discussion - Participatory question-answer	

Recommended literature:

1. Tropical Feeds, tropical Feeds. B. Gohl (1981). Food and Agricultural Organization of the United Nations, 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. ADCP/FEP/80/11 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.

0831-3204: Fish Processing

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course to complete 4-year B. Sc. Fisheries (Honours) degree. Content of the course mainly focuses on the fish processing methods including chilling, drying, smoking, salting, freezing, canning, fermentation, irradiation etc. The course provides the knowledge of different processing methods of fish and shellfish. The course also provides knowledge on factors influencing the quality and changes of fish during different processeing methods followed.

Learning Outcomes:

At the end of the course, the students will be able to: i) know the fish processing methods including chilling, drying, smoking, salting, freezing, canning, fermentation, irradiation etc. ii) understand the quality changes of fish and fishery products; and iii) make an idea to new fish processing method.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe and distinguish the freezing methods for fish and shellfish; explain the factors affecting the quality of fish & shellfish during freezing; describe the freezing process of shrimp/prawn in Bangladesh; mention the exportable shrimp/prawn items of Bangladesh.	4
CLO2	Describe and apply basic mechanism of drying with physical properties, methods, processing of fish and shellfish.	2
CLO3	Describe and apply smoking with its preservative effects and changes in fish during smoking.	2

CLO4	Outline and describe different types of salting with their application technologies, processes, characteristics and effects on shelf life of fish and shellfish.	3
CLO5	Describe principle, materials, operation, types of canning.	3
CLO6	Describe and apply basic mechanism of different fermented products with its effects and shelf life.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Describe and distinguish the freezing methods for fish and shellfish: explain the factors affecting the quality of fish & shellfish during freezing; describe the freezing process of shrimp/prawn in Bangladesh; mention the exportable shrimp/prawn items of Bangladesh.	- Lectures followed by discussion - Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	Drying and dehydration: Basic mechanism of fish drying, physical properties of fish in relation to drying, methods and processing, technology, drying of salt treated fish; quality aspects of dried fish.	- Lectures followed by discussion - Participatory question-answer	
CLO3	Smoking: Preservative effect and changes in fish during smoking, factors affecting smoking, quality aspects of smoked fish.	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO4	Salting: Types of salting, technological aspects of salting, salting process and characteristic features of salting, effect of salt quality on shelf life of salted fish.	- Lectures followed by discussion - Participatory question-answer	

CLO5	Canning: Principles of canning, preparation of raw material, canning operation, types and availability of can materials, tests of canned products.	- Lectures followed by discussion - Participatory question-answer	
CLO6	Fermentation: types, classification of fermented fishery products, process. Fish sauce, Shidol, Nga-pi. Constraints and suggestions for improved method.	- Lectures followed by discussion - Participatory question-answer	

Recommended literatures:

1. Fish as food. vol. I-IV. G. Borgstrom (editor) (1965). Academic press, London.
2. Fish Processing Technology. T. K. Govinda (1985). Oxford and IBH Publi. Co., New Delhi.
3. Post-harvest Technology of Fish and Fish Products. Balachandran, K. K. 2001. Daya Publishing House, Delhi – 110035. India. 440 pp.
4. Fish Handling, Preservation and Processing in the Tropics. Part I and II. I. J. Clusas (editor). (1985). Tropical Development and Research Institute, London.
5. Processing of Aquatic Food Products. F. W. Wheaton and T. B. Lawson (1985). Wiley Inter Science, New York.
6. Industrial Fishery Technology. M. E. Stausby (1963). Reihnold (editor). Publ. Corp. New York.
7. Advances in Fish Processing Technology by D. P. Sen. Sunil Sachdev. Allied Publishing Pvt. Ltd., New Delhi.
8. Modified atmospheric processing and packaging of fish, edited by W. Steven Otwell, Hordur G. Kristinsson, Murat O. Balaban. Blackwell Publishing Asia.
9. Fish Processing – Sustainability and New Opportunities, Edited by George M. Hall. 2011. Blackwell Publishing Ltd.
10. Food preservation techniques, Edited by Peter Zeuthen and Leif Bùgh-Sùrensen. 2003, Woodhead Publishing Limited and CRC Press LLC
11. Participatory Training of Trainers : A New Approach Applied in Fish Processing by Dr. A. K. M. NowsadAlam, 2007. Bangladesh Fisheries Research Forum (BFRF).

0831-3205: Genetics and Fish Breeding

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

The course provides an introduction to the theoretical background and practical application of genetics/genomics with modern technological knowledge and skills of fish breeding for designing

and managing stock improvement program to increase quantity and quality of aquaculture products under various production systems and advance the monitoring and management of natural fishery resources. The course will explore the genetic basis for physical traits (quantitative genetics). Inbreeding, hybridization, selection and biotechnology are discussed with their effects on aquaculture and fisheries. This course also teaches students the methodology of measurement of variance and covariance, heterosis, heritability, inbreeding co-efficient, breeding value, selection differential, selection response and selection index. The course covers basic concept of advance genetic engineering technology. Present scenario of hatchery and brood management in Bangladesh will be also discussed with recent stock improvement program used.

Learning Outcomes:

After completion of this course, the students will learn the use of genetics and biotechnology in breeding program to increase aquaculture production.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe definition and application of Fish Genetics and breeding in fisheries and aquaculture; Know and explain definition, application, and effects of inbreeding; Calculate and design preventive measures of controlling rate of inbreeding.	4
CLO2	Know and explain definition, application, genetic effects of crossbreeding and hybridization; Design crossbreeding and hybridization planning.	4
CLO3	Explain and design different methods of selective breeding program with their merits and demerits.	4
CLO4	Explain and apply ploidy and sex manipulations for fisheries and aquaculture.	4
CLO5	Describe gene structure, recombinant DNA technique, GMOs, LMOs and transgenics; Knows the use of genetic engineering and biotechnology in medicine, agriculture and fisheries.	4
CLO6	Evaluate hatchery facilities, broodfish selection, record keeping, inbreeding and genetic drift, Effective breeding number (Ne) of hatchery population; Describes and applies selective breeding and line-crossing technique of indigenous and exotic species for stock improvement.	4

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Introduction: application of fish genetics and breeding in fisheries and aquaculture. Inbreeding: Definition; Genetic effects and problems; Inbreeding depression; Practical application of inbreeding; Calculation of inbreeding; Effective breeding number (Ne); Genetic drift; Management measures to prevent inbreeding and genetic drift in hatchery	· Lectures followed by discussion · Participatory question-answer	Total (100) Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	Hybridization: Definition; Types of cross breeding; Application of hybridization; genetic effects; Natural and artificial hybridization; Hybridization planning; Outbreeding and hybrid vigour; Heterosis;	· Lectures followed by discussion · Participatory question-answer	
CLO3	Selection: Genetic variation and selection; Selection vs. neutralism; types of selection; Methods of selection; Individual selection; Family selection; Selection index; Combined selection; QUT and MAS	· Lectures followed by discussion · Participatory question-answer · Online resources	
CLO4	Chromosomal manipulations: Production and application of gynogens and androgens; Production and application of Triploids, tetraploids, haploids; Sex reversal and its application.	· Lectures followed by discussion · Participatory question-answer · Online resources	
CLO5	Genetic engineering: Gene structure; definition; recombinant DNA technique, GMOs, gene manipulation, use of genetic engineering and biotechnology in medicine, agriculture and fisheries.	· Lectures followed by discussion · Participatory question-answer · Online resources	
CLO6	Genetics of broodstock management: Sources of brood fish, broodfish selection, record keeping, inbreeding and genetic drift; Effective breeding number (N_e); Selective breeding and line-crossing technique of indigenous species for stock improvement. Genetic changes in hatchery populations; Unintentional selection and small population size; Fish seed certification and quarantine system.	· Lectures followed by discussion · Participatory question-answer · Online resources · Video demonstration	

Recommended literature:

1. Genetics for fish hatchery manager. D. Tave, 1993. 2nd ed. Van Nostrand Reinhold, New York.

2. Genetics. Strickberger, M. W. 1985. Prentice-Hall of India Pvt. Ltd. New Delhi-110001.
3. Principles of Genetics. Tamarin, R. H. 1999. McGraw Hill Inc. Book Co. New York, San Francisco, Toronto, London.
4. Biology of the Gene. Levine, L. 1980. The C. V. Mosby Company, St. Louis / Toronto / London.
5. Introduction to Genetic Analysis. Griffiths, J. F., Miller, J. H., Suzuki, D. T., Lewontin, R. C., Gelbart, W. M. 1998. W. H. Freeman and Company. New York.
6. The Principles of Heredity. Synder, L. H. and David, P. R. 1957. D. C. Health and Company, Boston.
7. Genetics. Verma, P. S. and Agarwal, V. K. 1975. S. Chand and Company Ltd., Ram Nagar, New Delhi-110055.
8. Fundamentals of Genetics. Sing, B. D. 2000. Kalyani Publishers, New Delhi.
9. V.S.Kirpichnikov. Genetic bases of fish selection.
10. Genetics and Fish Breeding: C.E.Purdom.
11. Practical Genetics for Aquaculture: C. Greglutz.
12. Theory and Problems of Genetics: William D. Stansfield
13. Genetics and Analysis of Quantitative Traits: Lynch M, Walsh B.

0831-3206: Geographic Information System (GIS) and Remote Sensing

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

The course covers various aspects of GIS such as spatial data models and their structure, spatial database technology, data supply for geographic information systems: digital maps, and digitizing as well as basics of remote sensing and thematic classification of multispectral data. The purpose of this course is to introduce the students with the basic concepts and principles of various components of remote sensing and also provide an exposure to GIS and its practical applications in fisheries and aquaculture.

Learning Outcomes:

At the end of the course, the students will be able to: i) recognize advantages, components, mode and approaches of GIS technique; ii) explain the relationship between IT and GIS; iii) familiarize with the different GIS models and software; iv) identify different maps for application in the field of fisheries and aquaculture v) know the generalized process of remote sensing vi) familiarize with image processing techniques vii)describe the application of remote sensing to fisheries and aquaculture.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe about history and development of GIS; Explain the use of information technology (IT) and information system in fisheries and aquaculture; Describe and demonstrate about different Elements of GIS and methods of data collection.	5
CLO2	Explain about structure, types, management and integration of GIS data; Describe different types of map, their application, and analysis;	3
CLO3	Describe and apply GIS Software: ARC/VIEW, ARC/INFO, IDRISI, a review of Cartalink; Describe the application of GIS in Fisheries and Aquaculture.	2
CLO4	Describe about history of remote sensing along with its application in fisheries and aquaculture; Explain electromagnetic energy, energy interaction in the atmosphere, and with the earth's surface; Describe about different types of sensors, and platforms.	7
CLO5	Explain aerial camera, aerial photography, and scale of aerial photo; Describe and give example of some operational space borne multispectral scanners; Describe about image classification principles and techniques with emphasis on unsupervised classification.	2
CLO6	Describe about history, divisions and activities of SPARRSO.	1

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Introduction: Overview, definition, approaches, GIS and other Information Systems. history and development of GIS; Use of information technology (IT) and information system in related field, contribution of GIS in IT revolution, general fields of GIS application; Elements of GIS: types of GIS- vector GIS and raster GIS, methods of data collection of vector GIS.	- Lectures followed by discussion - Power point presentation - Online resources	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	Data Management: Input, storage, manipulation and output of GIS, data	- Lectures followed by discussion	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
	structure and types- its management in raster and vector GIS, integration of vector and raster GIS; Map production and analysis: Type of maps and their application, systematic patterns of search, distribution points, uniform and cluster patterns, nearest-neighbour analysis, distribution lines, test for randomness, testing for a specific trend, test of goodness of fit, computer contouring, moving averages, kriging, trend surface.	- Power point presentation - Online resources	
CLO3	GIS Softwares: ARC/VIEW, ARC/INFO, IDRISI, a review of Cartalink; Application of GIS in Fisheries and Aquaculture.	- Lectures followed by discussion - Power point presentation - Online resources	
CLO4	Introduction to remote sensing: Historical overview, application of remote sensing in fisheries and aquaculture, generalized process of remote sensing; Electromagnetic energy and remote sensing: Electromagnetic energy, energy interaction in the atmosphere, energy interactions with the earth's surface; Sensors and platforms: Sensors, platforms, image data characteristics, data selection criteria.	- Lectures followed by discussion - Power point presentation - Online resources	
CLO5	Aerial camera: Aerial camera, spectral and radiometric characteristics, scales of aerial photo spatial resolution; Multispectral scanners: Some operational space borne multispectral scanners; Digital image classification: Preparation for image classification, unsupervised image classification.	- Lectures followed by discussion - Power point presentation - Online resources	
CLO6	History, divisions and activities of SPARRSO	- Lectures followed by discussion - Power point presentation - Online resources	

Recommended literature:

1. Principles of Geographical Information Systems for land Resource Assessment, P. A. Burrough.

2. Spatial processes, models and applications. A. D. Clifford J. K. Ord.
3. Introductory Readings in Geographic Information Systems. D. J. Penquet and D. F. Marble
4. Understanding GIS: The ARC/INFO Method. Esri.
5. Geographic Information Systems: a management perspective. S. Aronoff
6. Principles of Remote Sensing: An introductory text book. Edited by Lucus L. F. Janseen and Gerret C. Huurneman, 2001 ITC, Netherlands.
7. Imaging Radar for resource survey. Tervett.
8. Introduction to environmental remote sensing. Curtis.
9. Remote sensing application in marine science and technology. A. P. Cracknel.
10. Imaging Radar for resource survey. Tervett.
11. Introduction to environmental remote sensing. Curtis.
12. Principles of Remote Sensing ITC (Educational Textbook series; 2). Second Edition. Lucas L.F. Janssen and Gerrit C. Huurneman (eds.). (2001). ITC, Enschede, The Netherlands.
13. Introduction Geo-Information Science (GRS-10306). Kempen B. and W.TH. tenHaaf (Ed.). (2010). Wageningen University.
14. Fundamentals of Remote Sensing by CanadaCenter for Remote Sensing Remote Sensing Tutorial

Practical Courses

0831-3211: Practical on Fish Hatchery Management

Credit: 1
Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Identify different hatchery equipment.	2
CLO2	Identify brood fishes for successful breeding.	3
CLO3	Prepare dose of different inducing agents for induced breeding.	2
CLO4	Operate the steps of artificial breeding.	5
CLO5	manage brood and fry during transportation and culture.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Identification and operation of hatchery equipment.	- Lecture - Demonstration	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc)
CLO2	Selection and identification of brood fishes.	- Lecture - Demonstration	
CLO3	Dose preparation of different inducing agents.	- Lecture - Field work - Lab work	
CLO4	Demonstration of artificial breeding (induced and striping methods).	- Lecture - Field work - Lab work	
CLO5	Visit to a fin and shellfish fish hatchery and report writing.	- Lecture - Field work	

0831-3212: Practical on Fish Population Dynamics

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Estimate the considerations for gathering information of fish populations.	2
CLO2	Determine the catch per unit effort and estimate the population size using recorded length and weight data of fish in a sample. Estimate the length-length and length-weight relationships, and condition factors of fish populations.	3
CLO3	Calculate the population abundance by mark-recapture and depletion methods and to estimate the cohort and virtual population analysis.	3
CLO4	Estimate the age and growth of fish populations by length-frequency and hard part analysis; familiar with FISAT software and its application on computer for stock assessment	2
CLO5	Determinate the spawning- and peak-spawning season of aquatic animals by gonad-somatic index, external feature of gonads and their maturation stages. Estimate the fecundity of fishes through different methods.	2
CLO6	Estimate the total mortality, natural mortality and fishing mortality.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Sampling considerations for gathering information of fish populations.	- Lectures - Laboratory experiment - Analyzing data	**Full marks: 100** Attendance :10 Class record/Record:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Estimation of catch per unit effort; recording the length and weight of fish in a sample; estimation of population size. Establishment of length-length and length-weight relationships, and condition factors of fish populations	- Lectures - Laboratory experiment - Analyzing data	
CLO3	Estimation of population abundance by mark-recapture and depletion methods; cohort and virtual population analysis	- Lectures - Laboratory Experiment	
CLO4	Study of age and growth of fish populations by length-frequency and hard part analysis; familiar with FISAT software and its application on computer for stock assessment.	- Lectures - Laboratory Experiment	
CLO5	Determination of spawning season of aquatic animals by gonad-somatic index, external feature of gonads and their maturation stages; estimation of fecundity of fish species	- Lectures - Laboratory experiment	
CLO6	Estimation of total mortality, natural mortality and fishing mortality	- Lectures - Laboratory experiment	

0831-3213: Practical on Fish Feed Technology

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Identify different Fish feed stuffs such as plant and animal origin ingredients and packed feeds.	3
CLO2	Know the present status of commercially available plant and animal origin fish feed ingredients used with fish feed in different areas of Bangladesh.	3
CLO3	Demonstrate different Live feed culture and application in aqua farm.	2
CLO4	Compute Feed formulation using Square method, use of spreadsheet.	2
CLO5	Calculate the Formulation of balanced diet for fish species.	2
CLO6	Demonstrates different feeding methods for fish.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Fish feed stuffs: Identification of plant and animal origin ingredients and feeds.	Observation, Characteristics analysis Drawing	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Survey of commercially available plant and animal origin fish feed ingredients used with fish feed in different areas of Bangladesh.	Demonstration Characteristics analysis	
CLO3	Live feed culture and application	Observation, Demonstration Documentary film show	
CLO4	Feed formulation exercise: Square method, use of spreadsheet.	Calculation Power Point Presenting	
CLO6	Formulation of balanced diet for fish species.	Calculation Power Point Presenting	
CLO6	Observation of different feeding methods for fish.	Observation Demonstration Documentary film show	

0831-3214: Practical on Fish Processing

Credit: 1
Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Acquaint with fish processing laboratory.	2
CLO2	Demonstrate techniques of fish by sun drying and observe their physical and chemical changes.	3
CLO3	Demonstrate techniques of fish by smoking and observe their physical and chemical changes.	2
CLO4	Demonstrate techniques of fish salting and determine salt concentration with time interval.	2
CLO5	Visit processing plants and observe freezing process by different freezers.	2
CLO6	Demonstrate techniques of fish by fermentation and observe their physical and chemical changes.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Acquaintance with fish processing laboratory.	-Lecture -Demonstration	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Processing and preservation of fish by sun drying and observation on their physical and chemical changes.	- Lecture - Field work -Lab work	
CLO3	Processing and preservation of fish by smoking method and observation on their physical and chemical changes.	- Lecture - Field work - Lab work	
CLO4	Techniques of fish salting and determine salt concentration with time interval.	- Lecture - Lab work	
CLO5	Processing and preservation of fish by freezers.	- Lecture - Lab work	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO6	Techniques of fish by fermentation and observe their physical and chemical changes.	Lecture - Lab work	

0831-3215: Practical on Genetics and Fish Breeding

Credit: 1
Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Perform and produce monosex tilapia population using sex-reversad male/females	2
CLO2	Perform and identify sex of fish by gonad squashing and aceto-carmine staining method	2
CLO3	Describe androgenesis and gynogenesis process in tilapia	2
CLO4	Describe and perform selective breeding, hybridization, genetic drift, effective breeding number in fish	2
CLO5	Perform selection of breeders for induced breeding of fish	1
CLO6	Know the broodstock management practices by the hatchery operators to produce quality fish seeds and learn the problems currently faced by the hatchery operators/fish farmers.	1

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Production of monosex population in tilapia by using sex-reversed males/females.	Lectures Field experiment	**Full marks: 100** Attendance:10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Sexing of fish by gonad squashing and aceto-carmine staining method	Laboratory experiment	
CLO3	Induction of androgenesis and gynogenesis in tilapia	Lectures Laboratory experiment	
CLO4	Selective breeding, hybridization, genetic drift, effective breeding number in fish	Lectures Laboratory Experiment	
CLO5	Induced breeding of fish: selection of breeders	Lectures Laboratory Experiment	
CLO6	Field visit on public and privately-owned fish hatcheries with special reference to quality seed production currently faced by the hatchery operators/farmers.	Field visit	

0831-3216: Practical on Geographic Information System (GIS) and Remote Sensing

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Familiarize to GIS software and perform GIS data management.	2
CLO2	Identify different nodes. And describe query and overlay.	2
CLO3	Digitize and create map of an aquaculture site.	2
CLO4	Perform Satellite Image Processing: unsupervised classification.	2
CLO5	Identify Photographic feature.	1
CLO6	Determine scale of aerial photograph.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Introduction to GIS software and GIS data management	- Lectures followed by discussion - Practice ArcGIS	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Identify node and make query and overlay.	- Lectures followed by discussion - Online resources	
CLO3	Digitization and map production of an aquaculture site	- Lectures followed by discussion - Practice ArcGIS	
CLO4	Satellite Image Processing: unsupervised classification	- Lectures followed by discussion - Practice ArcGIS	
CLO5	Photographic feature identification	- Lectures followed by discussion - Solve problem	
CLO6	Scale determination of aerial photograph	- Lectures followed by discussion - Solve problem	

0831-3217: Excursion

Credit: 1

Full Marks: 100 (Attendance: 10 + Report: 30 + Presentation: 60)

Course Description:

This course is prerequisite to complete four years B.Sc. Fisheries (Honours) degree. An excursion (7 to10 days) will be conducted based on the prescribed sites and activities (including tour plan) as decided by the course teachers with the prior approval of the academic committee of the Department. Attended students will give a presentation and submit a report at the date decided by the examination committee. The prescribed sites and/or activities to be carried out under this

course are as follows: (1) Coastal and marine habitat: Study of physical, chemical and biological properties, collection of sediments; (2) Kaptai Lake fishery: Different species caught, harvesting method, aquaculture practice (if any), physical, chemical and biological properties; (3) Haor, baor, spring and mangrove fishery: Physical, chemical and biological properties, CBFM/Co-management activities; (4) Fish landing center: Different species found, valuable species, storage system, market and value chain; (5) Prawn and shrimp farms: Culture system, major problems; (6) Shrimp and prawn hatcheries: Brood, feed and seed quality, capacity, major problems; (7) Fish processing industries: Methods, application of standard; (8) Other fisheries sites(including hotspots) and activities.

Expected Outcomes

Upon completion of this course, the students will be able to describe different fisheries resources of Bangladesh through physical observation and present in written and oral form.

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

COs	**Course Learning Outcomes**	**Lectures**
CLO1	Identify coastal and marine habitats and conduct case study on a freshwater/coastal prawn farm	4
CLO2	Characterize fishery like haor/baor/swamp/lake/mangrove	2
CLO3	Observe operations/activities in freshwater/coastal prawn hatcheries and processing plant	4
CLO4	Observe species and marketing status and storage facilities of a fish landing centre	2
CLO5	Develop presentation based on findings/observations	2
CLO6	Prepare a report based on findings/observations	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	**PLOs**				
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson Plan

CLOs	**Course Contents**	**Teaching Strategy**	**Assessment Strategy**
CLO1	Identify coastal and marine habitats and conduct case study on a freshwater/coastal prawn farm	- Lecture followed by discussion - Participatory question-answer	**Full marks: 100** Attendance: 10 Report: 30 Presentation: 60

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
		- Field visit / Presentation	
CLO2	Characterize fishery like haor/baor/swamp/lake/mangrove	- Lecture followed by discussion - Participatory question-answer - Field visit / Presentation	
CLO3	Observe operations/activities in freshwater/coastal prawn hatcheries and processing plant	- Field visit - Presentation	
CLO4	Observe species and marketing status and storage facilities of a fish landing centre	- Field visit - Presentation	
CLO5	Develop presentation	- Participatory question-answer / Presentation	
CLO6	Prepare a report based on findings/observations	- Participatory question-answer / Presentation - Report writing	

Viva-voce Course

0831-3221: Viva-voce

Credit: 1
Full marks: 100

Course Learning Outcomes (CLOs):

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

CLOs	Course Learning Outcomes	Sessions
CLO1	Communicate and express verbally the knowledge obtained in an effective and clear manner on Coastal and Marine Aquaculture, Fish Genetics, Pathology and Immunology, Fisheries Post-Harvest Handling and Preservation, Oceanography, Rural Sociology and Fisheries Economics, Fish Hatchery Management, Fish Population Dynamics, Fish Feed Technology, Fish Processing, Genetics and Fish Breeding, Geographic Information System (GIS) and Remote Sensing.	12

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X

B. Sc. Fisheries (Honours) 4th Year 1st Semester Examination, January-June 2027

Theoretical Courses

0831-4101: Feed Manufacture and Live Feed Culture

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course for B. Sc. in Fisheries (Honours) degree with 8 semesters. The course introduce with feed manufacture, different non-nutrient and anti-nutrient component, natural and chemical contaminants of feed stuff. It categorizes feed additives as well as antibiotics - probiotics in aquafeed, and feeding stimulants and their impact on fish feed. At present, commercial fish culture in Bangladesh based on low cost formulated feed. So, the course describes fish feed manufacturing process and present status and problems of feed industry. The course is explained to feed storage and quality control of fish feed and also feed evaluating methods for promoting aqua-feed industry. This course also provides economically optimal dietary protein level feed for culturable fish and shrimp species in Bangladesh. Finally, this course will create an opportunity for entrepreneurship development of fisheries sub sector in Bangladesh.

Learning Outcomes:

At the end of the course, the students will be able to know about the fish non-nutrient and anti-nutrient component, natural and chemical contaminants of feed stuff, feed processing.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe non-nutrient component in fish feed. Categorizes antibiotics and probiotics in aquafeed, Feeding stimulants.	3
CLO2	Describe toxic constituents in feedstuffs: Antinutritional factors present in plant feedstuffs; adventitious toxic factors in feedstuffs. Explain Natural and chemical contaminants of feed stuff	6
CLO3	Discuss Feed processing and manufacturing plant: Basic steps in aquafeed manufactures. Feed mills and their design, component part of a feed mill and pellet mill; fish feed manufacturing process. Organize Feed industry in Bangladesh Status and problems of aquafeed industry, Floating and sinking feed manufacturing process. Nutritional quality of compounded feeds. Understand feed storage and damage of fish feed and quality control.	8
CLO4	Evaluate methods and utilize feed parameters: MWG, PWG, SGR, FCR, FCE, PER, NPU, ANPU and Digestibility.	3
CLO5	Label specification for fish and shrimp feed: Quality aspects of protein source, Characteristics of potential feed ingredients. Fish and shrimp Feeds and legal aspects. Create alternative Protein sources for fish feed: Plant and animal by-product, protein –sparing feeds and economically optimal dietary protein level	4

CLOs	Course Learning Outcomes	Lectures
CLO6	Present status and prospect of live food in aquaculture. Types and Culture of other food organisms. Culture of micro-crustaceans: Daphnia, Moina, Copepod and Cyclops and preservation and economics of fish food organism	4

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Non-nutrient component in fish feed. Antibiotics and probiotics in aquafeed, Feeding stimulants.	- Lectures followed by discussion - Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	**Toxic constituents in feedstuffs:** Antinutritional factors present in plant feedstuffs; adventitous toxic factors in feedstuffs. Natural and chemical contaminants of feed stuff	- Lectures followed by discussion - Participatory question-answer	
CLO3	**Feed processing and manufacturing plant:** Basic steps in aquafeed manufactures**.** Feed mills and their design, component part of a feed mill and pellet mill; fish feed manufacturing process. **Feed industry:** Status and problems of aquafeed industry, Floating and sinking feed manufacturing process. **Feed storage**: Storage and damage of fish feed during storage and quality control.	- Lectures followed by discussion - Participatory question-answer	
CLO4	**Feed evaluating methods and feed utilization parameters:** MWG, PWG, SGR, FCR, FCE, PER, NPU, ANPU and Digestibility.	- Lectures followed by discussion - Participatory question-answer - Online resources	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO5	**Labeling specification for fish and shrimp feed:** Quality aspects of protein source, Characteristics of potential feed ingredients. Fish and shrimp Feeds and legal aspects. **Creating alternative Protein sources for fish feed:** Plant and animal by-product, protein –sparing feeds and economically optimal dietary protein level.	- Lectures followed by discussion - Participatory question-answer	
CLO6	**Present status, and prospect of live food in aquaculture**. Culture of micro-crustaceans: Daphnia, Moina, Copepod and Cyclops **Culture of Culture of other food organisms**- storage of fish food organisms. Economics of live food culture.	- Lectures followed by discussion - Participatory question-answer	

Recommended literature:

1. Finfish Nutrition and Fish Feed Technology. vol. I-II. J. E. Halver and K. Tiews (editors) (1979). H. Heenmann GmbH and Co. Berlin.
2. Fish Feed Technology. Aquaculture Development and Coordination Programme 1980. ADCP/FEP/80/11 UNDP/FAO, Rome.
3. Fish Feeds and Feeding in Developing Countries. Aquaculture Development and Coordination Programme (1983). ACDP/REP/83/18 UNDP/FAO, Rome.
4. A Guide to Tilapia Feeds and Feeding. K. Jauncey and D. Ross. (1982). Institute of Aquaculture, University of Stirling, Scotland.
5. Feed and Feeding of Fish and Shrimp. M. B. New (1987). ACDP/REP/87/26 UNDP/FAO, Rome.
6. Fulks, W and Main, K. L. (eds) (1992). Rotifer and microalgae culture systems. Argent Laboratory Press. 364 pp.
7. Lavens and Sorgeloos (eds). 1996. Manual on the production and use of live food for Aquaculture. 295 pp.
8. Stottrup (2002) Live feed for fish. (in press) 336 pp.
9. Barnalee, G. (1980). Rotifers; biology and rearing technology. In: Barnabe, G. (ed). Aquaculture Vol. 1. ELLIS. HarwoodPublications, London, England.
10. Bhat, B. V. (1995). *Artemia*In: Live feed Hand book on Aquaculture. The Marine Products Export Development Authority(Ministry of Commerce, Government of India) Kochi, India.
11. Dhert, P; Sorgeloos, P. (1995). Live feeds in aquaculture. Info fish International, (2): 31-39.
12. Fogg, G. E. (1996) Algal culture and phytoplankton ecology. University of Wiscon press.
13. Omori, M. and T. Ikeda (1984). Methods in Marine Zooplankton Ecology, John Willy & Sons.

332 pp.
14. Simpson, K. L. Klein-mcPhee, G. & Beck. A. D. (1982). Zooplankton as food source. Proc. 2nd conf. on Aquaculture Nutrition. Biochem. and Physiol. Approchestio shellfish Nutrition. Rohoboth Beach, Delaware/USA; October, 180-201.
15. Stanley, J. G. and Jons, J. B. (1976). Feeding alage to fish. Aquaculture, 7: 219-223.

0831-4102: Fisheries Resources Management

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete four years B.Sc. Fisheries (Honours) degree. The course coverers fisheries resources as river, haor, baor, kaptai lake, beels, and brackish water and their management, organization and authority involve in fisheries management; types of conservation, habitats and its improvement. A number of further topics, like hazards and hazard management, fisheries regulation; fish acts, new fisheries management policy (NFMP), fisheries co-operatives and freshwater recreational fisheries in Bangladesh will be also focused in the course. The course is designed to strengthen the student's existing knowledge on fisheries resources management.

Learning Outcomes:

At the end of the course, the students will be able to: i) know about different types of fisheries resources and their management, habitat improvement technique both for lentic and lotic water habitat; ii) know about the open water fisheries management& iii) know the rules and regulations for the conservation of the fisheries resources.
At the end of the course, the students will be able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Define fisheries resources; fisheries management, management functions, organization and authority; and types of conservation. Describes the importance of life history to management, degree of movement, zone inhabited and manner of reproduction. Describe different types of habitat, objectives and necessity of habitat improvement; habitat improvement methods in standing and running water body. Know the objectives, principles and activities; problems and their mitigation; role of GOs and NGOs in development of fisheries co-operatives.	8
CLO2	Know different types of fisheries regulation; fish acts in Bangladesh, wildlife ordinance (aquatic) of Bangladesh; regulatory authority and application.	3
CLO3	Know the types of hazards; its sources, effects, detection and abatement of pollution; removal of obstruction, fish pass.	3
CLO4	Describe undesirable population, controlling methods- poisoning, netting,	4

CLOs	Course Learning Outcomes	Lectures
	weirs/electric shocker, biological control, liberalized fishing and water level control.	
CLO5	Describe river, haor, baor, kaptai lake, beels, and brackish water and their management. Define new fishing areas, its necessity and basic principles to create new fishing areas. Describe the management problems: and its solutions.	6
CLO6	Know the Jalmahal policy; new fisheries management policy (NFMP). Describe freshwater recreational fisheries with its present status and future prospects.	4

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Introduction: Definition and types of fisheries resources; definition of fisheries management, management functions, organization and authority; definition and types of conservation. Life-history data of fishes in relation to management: Importance of life history to management, salient features-degree of movement, zone inhabited and manner of reproduction. Habitat improvement in inland water: Definition and types of habitat, definition, objectives and necessity of habitat improvement; habitat improvement methods in standing and running water body. Fisheries co-operatives: Definition, objective, principles and activities of fisheries co-operatives; problems and their mitigation; role of GOs and NGOs in development of fisheries co-operatives.	Lectures followed by discussion Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO2	Fisheries regulations: Definition, purpose, theory, types and effective application of fisheries regulation; fish acts in Bangladesh, wildlife ordinance (aquatic) of Bangladesh; regulatory authority.	Lectures followed by discussion Participatory question-answer Online resources	
CLO3	Protection against hazards: Types of hazards; definition, sources, effects, detection and abatement of pollution; removal of obstruction, fish pass.	Lectures followed by discussion Participatory question-answer	
CLO4	Control of undesirable fish population: Concept of undesirable population, controlling methods- poisoning, netting, weirs/electric shocker, biological control, liberalized fishing and water level control.	Lectures followed by discussion Participatory question-answer Online resources	
CLO5	Open water fisheries management: River, haor, baor, kaptai lake, cholonbeel and other major beels, brackish water and sea management. Creation of new fishing areas: Definition, necessity and basic principles to created new fishing areas. Management problems: Predictions of abundance, natural balance and environmental monitoring; special problems of selected fisheries; inter-and in intra-specific relations.	Lectures followed by discussion Participatory question-answer	
CLO6	Openwater fisheries policy: Jalmahal policy; new fisheries management policy (NFMP). Freshwater recreational fisheries: Definition, objectives, present status and future prospects, management.	Lectures followed by discussion Participatory question-answer	

Recommended literature:

1. Fishery Science. G. A. Rounsefell and W. H. Everhart (1983). John Wiley and Sons. New York
2. Freshwater Fishery Biology (2nd ed.). K.F. Lagler (1956). W. C. Brown Co. Dubuque, Iowa, USA.
3. Inland Fisheries Management in Bangladesh. M. Aguero, S. Huq, A. K A. Rahman and M. Ahmed (editors) (1989). DoF, Dhaka, BCAS, Dhaka and ICLARM, Manila, Philippines.
4. Fishery Management. R. S. For and J. D. Bravshew (1961). Faber and Faber, London.
5. Status and potential of Bangladesh Fisheries. M. A. Karim (1978). MOFL. Govt. of the People's Republic of Bangladesh.

6. Freshwater Fisheries Management. R. G. Templeton (1984). Fishing News Books Ltd. London.
7. Management of Artificial Lakes and Ponds. G. W. Bennett (1965). Reinhold Publ. Corp., New York.

0831-4103: Fishery Byproducts Technology

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is an applied theoretical course and prerequisite to complete 4-year B. Sc. in Fisheries (Honours) degree. The course covers the different fishery by-products with their uses and processing methods. The course is designed to enhance the existing knowledge of students about the process of fishery by-products such as fishmeal, fish oil, fish silage, hydrolysate etc. This course can also teach them the processing and utilization of specialty products such as gelatine, fish glue, fish skin, chitin, pearl essence, pearl etc. This course also focuses on processing and utilization of nutraceutical products such as agar, alginate, iodine, insulin etc.

Learning Outcomes:

At the end of the course, the students will be able to- i) Know the different fishery byproducts and their uses ii) Know the processing methods of fishery byproducts & iii) Ensure the proper utilization of fish and shellfish.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	List the fishery by-products and explain the scope of fishery by-product production in Bangladesh.	1
CLO2	Explain the processing, preservation, quality deterioration and utilization of fishmeal, fish oil and fish silage.	6
CLO3	Explain the Processing, preservation, nutritive value, deterioration and utilization of fish hydrolysate and fish protein concentrate	4
CLO4	Describe and prepare the specialty products: Gelatin, fish glue, caviar, roe and milt, leather, chitin, chitosan, dried shark's fin, fish maws/Isinglass, ambergris, pearl essence, pearl, ornamental shell, tortoise shell and coral products.	4
CLO5	Define and discuss the processing methods of the nutraceutical and pharmaceutical products: agar, alginic acid and alginate, iodine, mannitol, insulin.	2
CLO6	Explain the extraction, storage and utilization of the taste and flavor active compounds in seafood	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	List the fishery by-products and explain the scope of fishery by-product production in Bangladesh	- Lectures followed by discussion - Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	Explain the processing, preservation, quality deterioration and utilization of fishmeal, fish oils and fish silage.	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO3	Explain the Processing, preservation, nutritive value, deterioration and utilization of fish hydrolysate and fish protein concentrate	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO4	Describe and prepare the specialty products: Gelatin, fish glue, caviar, roe and milt, leather, chitin, chitosan, dried shark's fin, fish maws/Isinglass, ambergris, pearl essence, pearl, ornamental shell, tortoise shell and coral products.	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO5	Define and discuss the processing methods of the nutraceutical and pharmaceutical products: agar, alginic acid and alginate, iodine, mannitol, insulin.	- Lectures followed by discussion - Participatory question-answer	
CLO6	Explain the extraction, storage and utilization of the taste and flavor active compounds in seafood	- Lectures followed by discussion - Participatory question-answer	

Recommended literature:

1. Fish as food. vol. I-IV. G. Borgstrom (editor) (1965). Academic press, London.
2. Fish Processing Technology. T. K. Govinda (1985). Oxford and IBH Publi. Co., New Delhi.
3. Post-harvest Technology of Fish and Fish Products. Balachandran, K. K. 2001. Daya Publishing House, Delhi – 110035. India. 440 pp.
4. Fish Handling, Preservation and Processing in the Tropics. Part I and II. I. J. Clusas (editor). (1985). Tropical Development and Research Institute, London.
5. Marine and Freshwater Products Handbook, edited by Roy E. Martin, Emily Paine Carter, Lynn M. Davis, George J. Flick Jr. 2000. Technomic publishing Company inc
6. Processing of Aquatic Food Products. F. W. Wheaton and T. B. Lawson (1985). Wiley Inter Science, New York.
7. Industrial Fishery Technology. M. E. Stausby (1963). Reihnold (editor). Publ. Corp. New York.
8. Introduction to Fishery By-Products. M. Windsor and S. Barlow (1981). Fishing News Books Ltd. Farnham, Surrey, England.
9. Fish Processing Technology. T. K. Govinda (1985). Oxford and IBH Publi. Co., New Delhi.
10. Processing of Aquatic Food Products. F. W. Wheaton and T. B. Lawson (1985). Wiley Inter Science, New York.
11. The Technology of Fish Utilization. K. Krenzer (1965). Fishing News (Books) Ltd. London.
12. Industrial Fishery Technology. M. E. Stausby (1963). Reihnold (editor). Publ. Corp. New York.
13. Fish processing Technology. T. K. Govindan (1985). Oxford and IBH Publishing Co. Pvt. Ltd. (New Delhi, Bombay, Calcutta).
14. Marine Products in Japan. E. Tanikawa (1985). Koseisha Co. Ltd

0831-4104: Fish Stock Assessment

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course provides students with a detailed understanding of the quantitative techniques employed in the assessment of fisheries stocks. The course covers fishery dependent and fishery independent data and its use in predictive modelling, mortality estimation, biomass and yield modelling, stock structure and size estimation. Relationships between population parameters and effects of fishing on ecosystems will be also discussed. This course aims to guide students in the use of bioinformatics applications available for the use of the information derived from the study of genomics and proteomics that can advance the stock assessment, monitoring and management program of natural fishery resources.

Learning Outcomes:

By the end of the course, students should be able to the (i) identification and separation of unit

stocks (ii) use of DNA in species identification and age determination (iii) genetic consequence of stock enhancement program (iv) stock abundance and its estimation by Mark-recapture and Depletion methods (vii) different conventional methods for estimation of stock status, maximum sustainable yield (MSY) and maximum economic yield (MEY).

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

CLOs	**Course Learning Outcomes**	**Lectures**
CLO1	Define and know the scope and importance of studying Fish Stock Assessment; Explain concept of unit stock, identification and separation of unit stocks. Explain bioinformatics, types of data, database and describe internet application in fisheries management	5
CLO2	Describe and explain use of DNA in species identification, age determination, fisheries surveillance, ecosystem monitoring, pathogens and invasive species detection for fisheries management.	4
CLO3	Explain and analyze patterns and extent of unit stock, Mixed-stock, harvest rate and abundance; Evaluate evolutionary response to fishing.	5
CLO4	Monitor genetic diversity for fisheries management and evaluate genetic consequence of stock enhancement program.	4
CLO5	Determine stock structure and size by Mark-recapture and Depletion methods. Explain different types of Fishery data, Logbooks and Sampling surveys. Explain and estimate stock parameters using different estimation methods and models.	6
CLO6	Describe and calculate relationships between population parameter estimations, stock assessment and fisheries management; Evaluate effects of fishing on target species, non-target species, environment and ecosystems.	4

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	**PLOs**				
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Introduction: Definitions, scope and importance, concept of unit stock, identification and separation of unit stocks, spacing within a unit stocks. Bioinformatics: Definition, types of data, database, internet, application in fisheries management.	Lectures followed by discussion Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	Use of DNA in fish Stock Assessment: Species Identification, Age determination, Fisheries Surveillance, ecosystem monitoring (Food-web, Environmental stress, effects of climate change), Detection of pathogens and invasive species	Lectures followed by discussion Participatory question-answer Online resources	
CLO3	Fisheries Stock Structure: Patterns and extent of biological stock; Mixed-stock analysis, harvest rate and abundance, Evolutionary response to fishing	Lectures followed by discussion Participatory question-answer Online resources Video demonstration	
CLO4	Monitoring Genetic diversity for fisheries Management; Genetic consequence of stock enhancement program. Stock structure and size: Stock abundance and its estimation by Mark-recapture and Depletion methods. Fishery-dependent and fishery-independent data, Logbooks and Sampling surveys.	Lectures followed by discussion Participatory question-answer Online resources	
CLO5	Stock assessment: Different conventional methods for estimation of fishing, natural and total mortality, Estimation of exploitation rate, Estimation of maximum sustainable yield (MSY) and maximum economic yield (MEY). Equilibrium models (surplus production models); non-equilibrium models (process-error and observation-error methods); potential yield estimators; biomass models; virtual population and cohort analysis; yield per recruit model; Thomson and Bell model; simulation and ecosystem models.	Lectures followed by discussion Participatory question-answer	
CLO6	Conclusion: Relationships between population parameter estimations, stock assessment and fisheries management; effects of fishing on target species, non-target species, environment and ecosystems.	Lectures followed by discussion Participatory question-answer	

Recommended literature:

1. King, M. 1995. Fisheries Biology, Assessment and Management. Fishing News Books, 342 pp.
2. King, M. 2007. Fisheries Biology, Assessment and Management. 2nd edition, Blackwell, 382 pp.
3. Sparre, P., E. Ursin and S.C. Venema. 1989. Introduction to tropical fish stock assessment. Part 1. Manual. FAO Fisheries Technical Paper. No. 306.1. Rome, FAO. 337 pp.
4. Cushing, D.H. 1968. Fisheries Biology: A study in population dynamics. Univ. Wisconsin, Madison, USA. 200 pp.
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. 223 pp.
6. Gulland, J.A. (ed.) 1988. Fish Population Dynamics. Second edition. John Wiley & Sons, Inc., New York.
7. Lagler, K.F. 1956. Freshwater Biology, Second edition, William C. Brown Co. Dubuque, Iowa. 421 pp.
8. Pauly, D. 1984. Fish population dynamics in tropical waters. A manual for use with programmable calculators. ICLARM, Manila, 325 pp.
9. Ricker, W.E. 1968. Methods of assessment offish production in freshwaters. Blackwell Scientific Publications, Oxford, 321 pp.
10. Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191: 382 p.
11. Rounsefell, G.A. and W.H. Everhart. 1953. Fishery Science: Its methods and application. John Wiley & Sons, Inc., New York. 444 pp.
12. Sparre, P., E. Ursin and S.C. Venema, S.C., 1989. Introduction to tropical fish stock assessment. Part 2. Exercises. FAO Fisheries Technical Paper. No. 306.2. Rome, FAO. 429 pp.

0831-4105: Fisheries Extension

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete four years B.Sc. Fisheries (Honours) degree. The course coverers principles, philosophy, objectives, scope, potentials and problems of fisheries extension, communication, extension teaching methods and teaching aids, learning, PRA tools/techniques, group, organization, participatory extension activities, innovation decision process, leadership, programme planning and evaluation. A number of further topics like, leadership, programme planning and evaluation and rural youth will be also focused in the course. The course is designed to strengthen the student's existing knowledge on fisheries resources management.

Learning Outcomes:

At the end of the course, the students will be able to: i) Explain the principle and philosophy for fisheries extension; ii) Apply techniques and tools for teaching-learning and communication in fisheries extension. iii) Recognize group, team, organization and leadership for fisheries extension; iv) Apply tools for new technology transfer; v) Identify research and extension need and develop extension programme.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Outline principles, objectives, scope, potentials and problems of fisheries extension in Bangladesh; Familiarize extension terminology: Knowledge, attitude, skill, education, research, development, need, motivation, stakeholder, participation, facilitation; Describe types and elements of communication.	3
CLO2	Explain concept, types, importance and use of extension teaching methods and teaching aids; Describe process, general principles of Learning; and distinguish traditional learning from participatory learning; Describe concept, importance, types, application and methods of PRA tools/techniques.	4
CLO3	Describe concept, mode and type of group; identify and manage critical members; form and mobilize group; Explain features of extension organization. Describe qualifications and responsibilities of extension personnel; Learn and perform participatory extension activities: case study, role play, brain storming, meeting, seminar, workshop, panel discussion etc.; Describe innovation decision process.	3
CLO4	Learn and describe concept, types and recognition of leadership.	3
CLO5	Explain programme planning and evaluation.	4
CLO6	Describe present condition, need, problem and prospect of rural youths for development of fisheries and related agricultural activities in Bangladesh.	3

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	**Introduction:** definition, principles, philosophy and objectives of extension; scope, potentials and problems of fisheries extension in Bangladesh; **Terminology:** Knowledge, attitude, skill, education, research, development, need, motivation, stakeholder, participation, facilitation; **Communication:** Definition, types and elements of communication.	- Lectures followed by discussion - Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	**Extension teaching methods and teaching aids:** Concept, types, importance and use; **Learning:** Definition, process, general principles, adult learning principles, traditional versus participatory learning; **PRA tools/techniques**: concept, importance, types, application and methods.	- Lectures followed by discussion - Participatory question-answer	
CLO3	**Group:** concept, mode and type of group; identification and management of critical members; group formation and mobilization, team building; **Organization:** Definition, main features of an extension organization, categories, qualifications, duties and responsibilities of extension personnel; **Participatory extension activities**: case study, role play, brain storming, meeting, seminar, workshop, panel discussion etc.; **Innovation decision process**: Meaning of diffusion, elements in the diffusion process, models of innovation-decision process, innovativeness and adopter categories, rejection and discontinuance of innovations, factors affecting transfer of technologies.	- Lectures followed by discussion - Participatory question-answer	
CLO4	**Leadership**: Concept and types of leadership, recognition for good leadership, role of professional and local leaders.	- Lectures followed by discussion - Participatory question-answer	
CLO5	**Programme planning and evaluation:** Concept, importance, principles and procedures of programme planning for	- Lectures followed by discussion - Participatory question-	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
	fisheries development; participation of people, favourable and unfavourable conditions for programme planning; principles, types and procedures for evaluation of programme.	answer	
CLO6	**Rural youth:** Role of rural youths in extension work, present condition of rural youth in Bangladesh, needs and interests of rural youths, past and present programme for development of youth in Bangladesh, youth programme in other countries, involvement of youth for development of fisheries and related agricultural activities.	- Lectures followed by discussion - Participatory question-answer	

Recommended literature:

1. Leadership and Dynamic Group Action. G. M. Belal, J. M. Bholen and J. N Raudabaugh (1972). Ames: The law Stale University Press.
2. Extension and Rural Welfare. O. P. Dahama (1976). Agra, Ramprasad and Sons.
3. Agricultural Extension Manual (The Training and Visit System). Development of Agricultural Extension. Ministry of Agriculture. Government of the People's Republic of Bangladesh.
4. Notes on Extension in Agriculture. Ivan Fay. Asia Publ. House, Bombay, New Delhi.
5. Extension Education in Community Development. M. C. Kamatch (editor). New Delhi, Directorate of Extension, Ministry of Food and Agriculture, Government of India.
6. An Introduction to Extension. A. T. Mosher (1978). Agricultural Development Council, New York
7. Agricultural Extension - A Reference Manual. A. H. Mander (editor) (1972). FAO, United Nations, Rome.
8. Leadership for Action in Rural Communities. D. W. Kreitlow, E. W. Aiton and A. P. Orrence (1965). The Interstate Printers and Publishers.

0831-4106: Research Methodology

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This is a basic theoretical course and prerequisite for completing 4-year B.Sc. in Fisheries (Honours) degree. This course has been designed to guide students to gain knowledge of basic theories and methods involved in scientific research. In addition, techniques and standards of thesis and

manuscript writing will also be discussed.

Learning Outcomes:

Upon completion of this course the student would be able to (i) identify research problems (ii) design, collection and analyze qualitative and quantitative data. (ii) employ appropriate statistical methods for data analysis; and (iii) prepare and publish scientific paper.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Develop the basic concept of scientific research. Identify research problems and gaps	4
CLO2	Know about concept and different types and steps involved in biological research	4
CLO3	Know and write thesis, scientific papers and other publications	6
CLO4	Know about ethical aspects of research. Describe appropriate data collection methods and their analyses	4
CLO5	Apply appropriate research design with data analysis techniques for laboratory and field based researches	4
CLO6	Gain knowledge of quality journal and drawbacks of various ranking systems. Know and use computer software in biological research	6

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategies	Assessment Strategy
CLO1	Background, pioneer, objective, expected outcome, importance and scope of the course. Research Problem and Design: Concept of research problem, problems encountered by researches in Bangladesh and its solution. Needs for research design, different research design, developing a research plan.	- Lectures followed by discussion	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	Concept and types of research, different steps of conducting research.	- Lectures followed by discussion	

CLOs	Course Contents	Teaching Strategies	Assessment Strategy
		- Problem solve	
CLO3	Thesis and scientific paper writing and publication: Introduction, materials and methods, results and observations, review of literature and references.	- Lectures followed by discussion - Paper screening	
CLO4	Research ethics. Data Collection and Analysis: Data collection methods, selection for appropriate method for data collection, problems of data processing, normality check of data, appropriate test for data analysis.		
CLO5	Designing research. Principles of experimental design, field lay-out and analysis of variance in completely randomized design, randomized block design and Latin square design, analysis of co-variance in a completely randomized design. Survey-based research designs.	- Lectures followed by discussion - Problem solve	
CLO6	Special issues in research: journals and ranking systems. Computer and its application in research: introduction of computers, data input and analysis, uses of various software.	- Lectures followed by discussion - Practical task - Problem solve	

Recommended literature:

1. How to write and publish a scientific paper, Robert A. Day (1996). Cambridge University Press, Canada.
2. Writing your thesis, Paul Oliver (2006), Vistaar Publications, New Delhi.
3. Introduction to information systems, James A. O'Brien.
4. Kothari CR (2004) Research Methodology: Methods and Techniques, 2nd revised edition. New Age International Publishers, India.
5. Das BC (2023) *Bioethics Theory, History and Usage*. Kathaprokash, Dhaka, Bangladesh.

Practical Courses

0831-4111: Practical on Feed Manufacture and Live Feed Culture

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcome	Lectures
CLO1	Survey of commercially available packed fish feed, chemicals etc. used with fish feed in different areas of Bangladesh.	3
CLO2	Preparation of moist, semi-moist, pellets, crumbles etc., Generate small scale pellets manufacturing process.	2
CLO3	Observation feeding intensity on pellets by different culturable species (aquarium experiment).	3
CLO4	Evaluation of fish feed Experimental diets.	3
CLO5	Visit to feed manufacturing plant and report writing.	1
CLO6	Live feed culture and application in fin fishes	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Survey of commercially available packed fish feed, chemicals etc. used with fish feed in different areas of Bangladesh.	- Lectures - Problem solve	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Review on non-nutrients and toxic component found in fish feed ingredients.	- Lectures - Problem solve	
CLO3	Preparation of moist, semi-moist, live feeds, pellets and crumbles.	- Lectures - Laboratory experiment - Analyzing data	
CLO4	Observation feeding intensity on pellets by different culturable species (aquarium experiment).	- Lectures - Laboratory Experiment	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO5	Generate small scale pellets manufacturing process.	- Lectures - Laboratory Experiment	
CLO6	Evaluation of fish feed Experimental diets. Visit to feed manufacturing plant and report writing.	- Lectures - Laboratory experiment - Problem solve - Field visit	

0831-4112: Practical on Fisheries Resources Management

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Outline fisheries resources in Bangladesh. Describe fisheries management of river, haor, baor, lake, beel and flood plain	4
CLO2	Outline and manage Fish sanctuary.	2
CLO3	Describe management and conservation aspects of fish pass.	2
CLO4	Explain fisheries management and food security	2
CLO5	Understand and explain fish acts in Bangladesh	2
CLO6	Report field visit on fisheries management techniques.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Fisheries resources in Bangladesh. Riverine, haor, baor, lake, beel and flood plain fisheries management.	- Lecture - field visit	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Fish sanctuary: Management and conservation aspects	- Lectures - field visit	
CLO3	Fish pass: Management and conservation aspects	- Lectures - field visit	
CLO4	Fisheries management and food security	- Lectures	
CLO5	Fish acts in Bangladesh	- Lectures	
CLO6	Field visit and report writing on fisheries management techniques.	- Lectures - Field visit	

0831-4113: Practical on Fishery Byproducts Technology

Credit: 1
Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	List of fishery by-products available in Bangladesh.	1
CLO2	Prepare fish paste and assess their quality	2
CLO3	Prepare FPC and assess their quality	2
CLO4	Prepare fish meal and fish oil and assess their quality	3
CLO5	Prepare FPI and assess their quality	1
CLO6	Explain the processing and equipment required in a fishery by-products manufacturing industry	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Identification of fishery by-products available in Bangladesh.	- Lectures followed by discussion - Participatory question-answer - Laboratory	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Preparation of fish paste and their quality assessment.	- Lectures - Laboratory - Experiment	
CLO3	Preparation of FPC and their quality assessment.	- Lectures - Laboratory Experiment	
CLO4	Preparation of fish meal and fish oil and their quality assessment.	- Lectures - Laboratory Experiment	
CLO5	Preparation of FPI and their quality assessment.	- Lectures - Laboratory Experiment	
CLO6	Visiting fisheries byproducts manufacturing industries/plants.	- Lectures - Plant visit	

0831-4114: Practical on Fish Stock Assessment

Credit-1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Identify and separate unit stock by morphological and meristic data	2
CLO2	Estimate stock abundance using different methods	2
CLO3	Estimate and infer relationship between population parameter and stock assessment	1
CLO4	Estimate genetic diversity from DNA and protein data. Upload protein and DNA data in Genebank.	1
CLO5	Assess unit and mixed-stock using DNA data	1
CLO6	Assess the effects of abundance and harvest rate using eDNA data	1

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Identification and separation of unit stocks through morphological- and meristic characters and reproductive-growth parameters,	- Lectures - Problem solve	**Full marks: 100** Attendance : 10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Stock abundance and its estimation by Mark-recapture and Depletion methods. Fishery-dependent and fishery-independent data, Logbooks and Sampling surveys.	- Lectures - Problem solve	
CLO3	Relationships between population parameter estimations, stock assessment and fisheries management; effects of fishing on target species, non-target species, environment and ecosystems.	- Lectures - Laboratory experiment - Analyzing data	
CLO4	Estimation of Genetic diversity from DNA and protein data. Uploading protein and DNA data in Gene bank.	- Lectures - Laboratory Experiment	
CLO5	Use of DNA data for unit and mixed-stock assessment	- Lectures - Analyzing data	
CLO6	Use of DNA data for estimation of abundance and harvest rate	- Lectures - Analyzing data	

0831-4115: Practical on Fisheries Extension

Credit: 1
Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Collect fisheries extension data.	1
CLO2	Prepare questionnaire or interview schedule for data collection. Survey fisheries condition and develop presentation on survey report.	2
CLO3	Prepare session plan based training programme and practice training.	2
CLO4	Prepare and use extension communication materials: leaflet/folder, poster, flash cards.	1
CLO5	Prepare extension programme and annual calendar of work for fisheries development in an area	2
CLO6	Participate briefing sessions and observe demonstrations to acquaint with different fisheries development programme and to identify research and extension needs of an area through field visit.	3

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Collection of basic fisheries extension data.	- Lectures followed by discussion - Office visit	**Full marks: 100** Attendance : 10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/
CLO2	Preparation of questionnaire or interview schedule for collection of data from the villages. Survey of fisheries condition, preparation and presentation of survey report.	- Lectures followed by discussion - Field visit	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO3	Preparation of session plan based training programme and practice training.	- Lectures followed by discussion	Presentation/ Spotting, etc.)
CLO4	Preparation and use of extension communication materials: leaflet/folder, poster, flash cards.	- Lectures followed by discussion	
CLO5	Preparation of extension programme and annual calendar of work for fisheries development in an area	- Lectures followed by discussion	
CLO6	Participate briefing sessions and observe demonstrations to acquaint with different fisheries development programme and to identify research and extension needs of an area through field visit.	- Lectures followed by discussion - Field visit	

0831-4116: Practical on Research Methodology

Credit- 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Search and find different literature for scientific research	2
CLO2	Collect research samples and analyse data properly	2
CLO3	Select appropriate statistical tests for data	2
CLO4	Prepare posters and presentations	2
CLO5	Analyse data using different statistical software	3

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson Plan

CLOs	Course Contents	Teaching Strategies	Assessment Strategy
CLO1	Searching of literature and information from books, dissertations, abstracts, journals and periodicals for building up bibliographies.	- Lectures - Literature searching - Group tasks	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Research design, sample collection and data analysis	- Lecture - Field survey - Screening of papers	
CLO3	Different statistical tests selection and its application with collected data	- Use of software	
CLO4	Preparation of poster and power point presentation	- Use of software	
CLO5	Different fisheries software run through computers using collected data	- Use of software	

0831-4117: Research Work

Credit: 2
Full Marks: 100 (Attendance 10, Presentation 30, Thesis 60)

Course Description:

This course is a prerequisite to complete four years B.Sc. Fisheries (Honours) degree. Students will carry out a research work at the 1st Semester of 4th Year. At the beginning of Semester all the students will be attached to the academic staff (teachers available in the department) as their research supervisor. Students will deliver two presentations, presentation-1 based on introduction and methodology (10 marks) and presentation-2 based on results-discussion, conclusion and recommendation (20 marks). Finally, they will submit a thesis (60 Marks) based on research findings at the date decided by the examination committee. Thesis may be consisted of abstract (10 marks) introduction (including problem statement, review of literature, importance and objective) (10 marks), materials and methods (10 marks), results and discussion (15 marks), conclusion and recommendation (5 marks) and reference/literature cited (10 marks). Thesis must be certified by the research supervisor.

Expected Outcomes:

Upon completion of this course the student would be able to (i) identify research problems; (ii) design, collection and analyse qualitative and quantitative data; (iii) employ appropriate statistical methods for data analysis; and (iv) prepare and publish scientific paper.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Identify research problems	3
CLO2	Prepare experimental/research design	3

CLOs	Course Learning Outcomes	Lectures
CLO3	Collect and analyse data	6
CLO4	Develop presentation based on research findings	2
CLO5	Prepare scientific report (thesis)	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Identify research problems	- Lecture followed by discussion - Participatory question-answer - Field visit/Lab work - Presentation	**Full marks: 100** Attendance: 10 Presentation: 30 Thesis: 60
CLO2	Prepare experimental/research design	- Lecture followed by discussion - Participatory question-answer - Field visit/Lab work - Presentation	
CLO3	Collect and analyse data	- Field visit/Lab work - Presentation	
CLO4	Develop presentation	- Presentation	
CLO5	Prepare report/thesis based on the collected data	- Participatory question-answer - Presentation - Thesis writing	

B. Sc. Fisheries (Honours) 4th Year 2nd Semester Examination, July-December 2027

Theoretical Courses

0831-4201: Aquaculture Engineering and Farm Management

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered**)**

Course Description:

This course is a basic theoretical course to complete 4-year B. Sc. Fisheries (Honours) degree. Content of the course mainly focuses on the basic components to establish a fish farm along with its management systems. The course covers the general criteria of site selection and soil properties. The course provides the structural features, design, placement and other necessary criteria of pond construction. The course also provides knowledge on water quality monitoring, water recycling and wastewater treatment, different devices used in fish farm management. Content of the course will strengthen students' ability to manage any type of aquaculture farm.

Learning Outcomes:

At the end of the course, the students will be able to- i) select suitable site for establishing fish farms ii) design any fish and shrimp farms iii) estimate cost for establishing fish farms iv) minimize the constraints of a fish farm.

CLOs	Course Learning Outcomes	Lectures
CLO1	Recognize the status and importance of aquaculture engineering in Bangladesh.	2
CLO2	Understand and apply different criteria for constructing a fish farm.	5
CLO3	Design and explain the structural details for constructing different types of ponds; and able to establish fish and shrimp hatcheries along with their cost estimation.	7
CLO4	Apply various tools and techniques for water recycling; and analyze water quality for proper management of fish and shrimp farms.	6
CLO5	Apply different pumps and aeration devices for refill and oxygenation the ponds and tanks.	5
CLO6	Design and construct different safety measures for fish farm.	3

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Aquaculture engineering, importance and present status in Bangladesh.	-Lecture -Power point presentation	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	**Site selection and soil survey:** General consideration and social criteria of site selection for freshwater and brackish water fish farm; soil components, physical properties and classification of soil, soil topography and its survey.	-Lectures followed by discussion -Participatory question-answer -Power point presentation -Online resources	
CLO3	**Pond construction and farm design:** Pond types, criteria of pond construction, calculation dike/wall height and slope, wall volumes; designing of pits, placements of inlets and outlets; sluices and monks Structural feature of fish and shrimp farm, placement of ponds and layout of fish and shrimp hatcheries.	-Lectures followed by discussion -Participatory question-answer -Power point presentation -Online resources	
CLO4	**Water recycling and monitoring:** Techniques of wastewater treatment, use of filter/screen, and water flow/level measurements for water recycling; Water quality improvement, metabolic rate, DO, pH consumption and excretion, turbidity, sludge/pit, handling/removal.	-Lectures followed by discussion -Participatory question-answer -Power point presentation -Online resources	
CLO5	**Pumps and aeration devices for fin fish farm:** Use of pumps in fish culture, types of pump (common air pump, submersible aerator and floating aerator, blowers), general principle of aeration in aquaculture; aeration of ponds and tanks (screens and grading devices).	-Lectures followed by discussion -Participatory question-answer -Power point presentation -Online resources	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO6	**Fencing for fin fish farm:** Types, structure and construction.	-Lectures followed by discussion -Participatory question-answer -Power point presentation	

Recommended literatures:

1. Aquaculture Engineering. Odd-IvarLekang (2007). Blackwell Publishing Ltd., Oxford, UK.
2. Aquaculture Engineering. F. W. Wheaton (1987). Robert E. Krieger Pnbl., Florida.
3. Aquaculture Engineering. F. W. Roberts (1987). Robert E. Krieger Publ., Florida.
4. Textbook of Fish Culture; Breeding and Cultivation of Fish. M. Huet (1979). Fishing News Books. Ltd. Farnham Survey, England.
5. Designs and Construction of Earth Dams. K. D. Nelson (1985). Inkata Press, Melbourne.
6. Elementary Guide to Fish Culture in Nepal. E. Woynarovitch (1975). FAO, Rome.
7. Waste Water Treatment. M. N. Rao and A. K. Datta (2002). Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, India.
8. Aquatic Plants for the Waste Water Treatment. A. R. Upadhyay (2004). Daya Publishing House, Delhi, India.
9. Simple Methods for Aquaculture Management for Freshwater Practices. FAO Training Series 21/1. 1997. Baba BarkaNath Printers, New Delhi, India.
10. Textbook of Fish Culture; Breeding and Cultivation of Fish. M. Huet (1979). Fishing News Books. Ltd. Farnham Survey, England.
11. Designs and Construction of Earth Dams. K. D. Nelson (1985). Inkata Press, Melbourne.

0831-4202: Fish Health Management and Pharmacology

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete 4-year B. Sc. in Fisheries (Honours) 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 this course, the students will be able to: i) explain the major health related problems of fish and shrimp; ii) perform clinical examination and basic laboratory tests to diagnose fish and

shrimp diseases; iii) know the prophylactic and therapeutic measures for the control of fish and shellfish diseases; iv) know the pharmacodynamics and pharmacokinetics of select drugs; v) plan and develop experimental trials on issues of health, infections, diagnosis, prevention and therapy of fish and shrimp diseases. At the end of the course, the students will be able to-

CLOs	**Course Learning Outcomes**	**Lectures**
CLO1	Define health and health management; know the objectives and the basic concept of fish health management. Understand the sanitation practices for fish ponds and tanks, recirculation systems; water, diets, animals, hands, feet and equipment, new species, eggs, design facility.	4
CLO2	Know the principles and techniques of disease diagnosis. Define prevention and control of fish disease; know the significance of disease prevention and control; explain the prevention and control ways of common infections and noninfectious fish diseases	4
CLO3	Describe the types of therapy and the therapeutic treatments. Know the methods of vaccination, factors determine how well a vaccine will work, the requirement for developing a vaccine	4
CLO4	Know the pharmacological terms, scope, history and importance of pharmacology in aquaculture sector; understand the selection criteria of appropriate drugs, know the list of approved and prohibited aqua medicines, trade and generic names of major aqua-drugs Know the sources of drugs, nomenclature and classification, principles of drug activities and elimination of drugs; understand the concept of drug receptor, dose response relationship, half-life and withdrawal period, MRL factors affecting drug effect and dosage, pharmacogenetics	4
CLO5	Describe the antibacterial, antiviral, antifungal, antiparasitic, antiseptic and disinfectant; know the major groups of antibiotics, their uses, abuses, mode of actions Compare the pre- and probiotics, immunostimulants, herbal medicines, vaccines and adjuvants, antimicrobial peptides and their potential use as therapeutants in aquaculture	4
CLO6	Understand the food safety regulations, toxic effects, AMR, safety of target species, operator, consumer and environment; explain the welfare aspects of aquatic veterinary medicine, immunosuppressive drugs, drug control Acts, regulations and legislations; know the guidelines for the control of aquaculture medicinal products, market authorizations	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	**PLOs**				
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	**Introduction of health management:** Definition, principles, basic concept and importance of fish health management. **Sanitation practices in aquaculture:** Sanitation practices for fish ponds and tanks, recirculation systems, water, feed, animals, hands, feet and equipment, transplantation of new species, eggs and fish, design facility.	- Lectures followed by discussion - Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	**Diagnosis of fish disease:** Principles of disease diagnosis, epidemiological and clinical diagnosis, postmortem examination, microbiological, histopathological and haematological methods. **Prevention and control of fish disease:** Definition, significance of prevention and control of' disease, general preventive and control measures of disease, preventive and control measurer of pathogenic and non-pathogenic fish diseases.	- Lectures followed by discussion - Online resources	
CLO3	**Therapy of fish diseases:** Definition and types of therapy, chemotherapy, selection of drugs and their mode of actions, methods of application of drugs, use of common drugs in aquaculture. **Vaccination in aquaculture:** Definition, types and mode of action of vaccine, definition, general principles and methods of fish vaccination, commercial fish vaccines, use of adjuvant and immunostimulants, effectiveness of a vaccine, advantages of vaccination over chemotherapy, prospect of vaccine development.	- Lectures followed by discussion - Online resources	
CLO4	**Introduction of pharmacology:** Pharmacological terms and definitions, scope, history and importance of pharmacology in aquaculture sector; selection criteria of appropriate drugs, list of approved and prohibited aqua-	- Lectures followed by discussion - Online resources Slide show - Video demonstration	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
	drugs/medicines, aqua-drug companies, trade and generic names of major aqua-drugs **Pharmacokinetics and pharmacodynamics:**Sources of drugs, nomenclature and classification, principles of drug activities and elimination of drugs; concept of drug receptor, dose response relationship, half-life and withdrawal period, MRL factors affecting drug effect and dosage, pharmacogenetics		
CLO5	**Anti-pathogenic agents:** Antibacterial, antiviral, antifungal, antiparasitic, antiseptic and disinfectant; major groups of antibiotics, their uses, abuses, mode of actions, factors influencing the clinical use of antibiotics **Health beneficiary products:** Pre- and Pro-biotics, Immunostimulants, herbal medicines, Vaccines and adjuvants (types, development, production, administration, potency/ efficacy, marketing), antimicrobial peptides and their potential use as therapeutants in aquaculture	- Lectures followed by discussion - Online resources -	
CLO6	**Safety of aquatic medicine**: food safety regulations, toxic effects (toxicology), AMR (Anti-microbial resistance), safety of target species, operator, consumer and environment, welfare aspects of aquatic veterinary medicine, immunosuppressive drugs, drug control Acts, regulations and legislations in various countries including Bangladesh; Guidelines for the control of aquaculture medicinal products (AMPs), market authorizations	- Lectures followed by discussion - Online resources -	

Recommended literature:

1. Introduction to Fish Health Management. Vinyl Bound (1995) by Becky A. Lasee (Editor)
2. Introduction to Fish Health Management (1995). Becky A. Lasee, LaCrosse Fish Health Center (U.S.), La Crosse Fish Health Center.
3. Fish Diseases vol. 1 and 2. W. Schaperclaus (1991). Oxanion Press Pvt. Ltd. New Delhi, Calcutta.

4. Bacterial Pathogens; Diseases in Farmed and Wild Fish. B. Austin and D. A. Austin (1987). Ellis Horwood Ltd.
5. Diseases of Fishes (1971). S. Sarig (Edited by- Dr. Stanislaus, F. Snieszko and Dr. Herbert R. Axelrod). T. F. H. Publications Inc. Ltd.
6. Identification of Fish Pathogenic Bacteria. G. L. Bullock (1980). TFH Publication.211
7. Fish Pharmacology and Toxicology (2017), G. Pandey. DAYA Publishing House. Fish Medicine: 2nd edition (2011), Michael Stoskopf. Vet Book.

0831-4203: Aquatic Pollution and Toxicology

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete 4-year B. Sc. in Fisheries (Honours) degree. The course covers the aquatic pollution, their sources, impact and mitigation measures. The course is designed to strengthen the student's existing knowledge on agricultural, industrial and aquaculture pollution and their effect on aquatic organisms and ecosystem. This course can also teach them about ecological implications of algal toxins in aquatic food webs and mode of action of toxins in seafood poisoning. A number of further topics, like the, degradation of coastal environment and their impact on coastal and marine fisheries, measures for maintenance of coastal and marine environment for all living organisms will be also focused in the course.

Expected Outcomes:

After completion of this course, the students will be able to: i) know about the aquatic pollution, their sources, impact on aquatic biota and mitigation measures; ii) know about the algal toxins and seafood poisoning.

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

COs	**Course Learning Outcomes**	**Lectures**
CLO1	Discuss about sources, impacts of pollution and its mitigation measures	3
CLO2	Describe the agricultural pollution and its impact on fisheries resources	2
CLO3	Explain industrial pollution and its impact on fisheries resources	2
CLO4	Discuss about aquaculture pollution nutrient accumulation and eutrophication and drainage effect on the adjacent areas and water bodies	3
CLO5	Explore ecological implications of algal toxins in aquatic food webs and mode of action of toxins in seafood poisoning	2
CLO6	Discuss about causes and nature of degradation of coastal and marine environment	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	**Aquatic environment and pollution:** Key concepts, importance of aquatic environmental maintenance, sensitivity of aquatic biota on environmental changes (DO, pH, NH_3 & NO_2, harmful gases, turbidity, salinity), aquatic pollution, sources of pollution, impacts of pollution on aquatic plants, animals and human health	- Lectures followed by discussion - Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	**Agricultural development and pollution:** Trends in agricultural development and HYV, inputs used in agriculture (fertilizers, insecticides & pesticides), pollution due to agricultural wastes and pesticides, impacts on aquatic resources	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO3	**Industrial development and pollution:** Types of industries, location, raw materials used, sources and types of industrial byproducts and pollution, toxic effects of pollutants from tannery, pharmaceutical, dying and textiles, fertilizers, and chemical industries on freshwater and marine ecosystems	- Lectures followed by discussion - Participatory question-answer	
CLO4	**Aquaculture development and environment:** Culture practices and related problems, land and water use, materials and inputs used (feeds, fertilizers, chemicals and therapeutants), nutrient accumulation and eutrophication, drainage effect on the adjacent areas and water bodies, loss of natural habitats - mangroves, agricultural lands, livestock pastures etc., suggestions for	- Lectures followed by discussion - Participatory question-answer	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
	sustainable growth of aquaculture industries.		
CLO5	**Algal toxins:** Toxic algal blooms, ecological implications of algal toxins in aquatic food webs, mode of action of toxins in seafood poisoning, Paralytic Shellfish poisoning (PSP), Diarrhetic Shellfish Poisoning (DSP), *Ciguatera* Fish Poisoning (CFP), *Pfiesteria* toxin, domoic acid, links between algal toxin, biological changes and productivity, control strategies	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO6	**Coastal and marine environment degradation:** Causes and nature of degradation of coastal and marine environment (urbanization, tourisms, shrimp farming, sewages, municipal wastes, disposal of solid wastes, industrial wastes, ship breaking activities, oil spillage etc.), impact on coastal and marine fisheries, measures for maintenance of coastal and marine environment for all living organisms	- Lectures followed by discussion - Participatory question-answer - Videos	

Recommended literature:

1. Alabaster, J. S. and R. Lloyd. 1982. Water Quality Criteria for Freshwater Fish. 2nd Ed. Butterfly Scientific Publisher, London. 361 pp.
2. Lloyd, R. 1992. Pollution and Freshwater Fish. Fishing News Books, Oxford, UD. 176 pp.
3. Moriarty, F. 1993. Ecotoxicology: The Study of Pollutants in Ecosystems. Second Edition. T. J. Press (Padstow) Ltd., Padstow, Cornwall, Great Britain. 289 pp.
4. Boyd, C. E. 1988. Water Quality Management for Pond Fish Culture. Elsevier Scientific Publisher B. V., Amsterdam. 318 pp.
5. Calhoun, Y. 2005. Water Pollution. Chelsea House Publishers. 164 pp.
6. Calow, P. 1993 (ed.) Handbook of Ecotoxicology. Volume One. T.J. Press (Padstow) Ltd., Padstow, Cornwall, Great Britain. 289 pp.
7. Carmichael, W. W. 1981 (ed.). The Water Environment: Algal Toxins and Health. Plenum Press. New York. 491 pp.
8. Chorus, I. 2001 (ed.). Cyanotoxins–Occurrence, Causes, Consequences. Springer. 357 pp.
9. Falconer, I. R. 1993. Algal Toxins in Sea Food and Drinking Water. Academic Press. 224 pp.
10. Laws, E. A. 2000. Aquatic Pollution: An Introductory Text. 3rd Ed. Wiley. 639 pp.
11. Saxena, M. M. 1990. Environmental Analysis: Water, Soil and Air. Second Edition. Agro Botanical Publishers (India). 186 pp.
12. Smol, S. 2005. Pollution of Lakes and Rivers. A Hodder Arnold Publication.
13. Ulrich, F. 1981. Metal Pollution in the Aquatic Environment. Springer Verlag.

0831-4204: Aquatic Biodiversity and Conservation

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

The course gives an introduction to the diversity of aquatic bio-resources, conservation biology, ecology, socio-economy etc. and common genetic approaches to assess and conserve the environment and the biological diversity for sustainable natural resource management and aquaculture. Major aspects are biodiversity through history, the value of biodiversity, loss of biodiversity, and the theoretical foundations for conservation strategies aimed at protecting the long-term survivability of a species in a changing environment. The course also covers threatened aquatic biodiversity with criteria and categories for red-list at global and country level.

Learning Outcomes:

After completion of this course, the students will learn the importance of different components of biodiversity and also the techniques for conservation of these biodiversity.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Define fisheries Biodiversity; knows value of fish biodiversity; describe types of fisheries biodiversity. Interpret concept of species diversity; distinguishes zoogeographical distribution of fishes; outlines fishes of Bangladesh. Explains parameters and theories of genetic diversity for management of natural fish populations; Explain and apply different molecular techniques used in fisheries management and conservation with their application. Explains effects of inbreeding, genetic drift, founder effects, bottleneck, hybridization and gene introgression on fish populations and their methods of detection and interpretation of genetic data.	8
CLO2	Identifies the causes for the loss of fisheries biodiversity and evaluate the effects of environmental degradation, species introduction and hatchery-produced fish ranching on wild fisheries biodiversity.	4
CLO3	Proposes methods and strategies of fisheries biodiversity conservation; Design and plan for genetical conservation of exploited fishes and returning local fish biodiversity with special emphasis on Bangladesh perspectives	2
CLO4	Assess the status of biodiversity and ecosystem using different indices of measuring biodiversity. Explains environmental factors of fish habitat and biodiversity, recognizes fisheries hotspots.	3

CLOs	Course Learning Outcomes	Lectures
CLO5	Outlines fisheries biodiversity at global and country level; Explain and outlines the red listed fish species and other fisheries items using criteria and category proposed by IUCN. Identify protected species.	4
CLO6	Assess the temporal and spatial changes in aquatic habitat and its biodiversity. Explain biological invasion and associated theories.	7

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Fisheries biodiversity: Define fisheries Biodiversity; knows value of fish biodiversity; describe types of fisheries biodiversity. Species diversity: Interprets concept of species diversity; distinguishes zoogeographical distribution of fishes; outlines fishes of Bangladesh. Habitat diversity. Genetic diversity: Explains genetic variation and population structure, Heterozygosity; interprets genetic variation within populations and between populations; Defines gene and genotype frequency; Explains Hardy-Weinberg equilibrium; Defines Population differentiations (F_{st}) and Effective breeding number (N_e); Quantify level of genetic variation: Explains Polymerase chain reaction (PCR), Protein Electrophoresis, Restriction fragment length polymorphism (RFLP), Amplified fragment length polymorphism (AFLP), Random amplified polymorphic DNA (RAPD), mini and microsatellite VNTRs; Outlines	- Lectures followed by discussion - Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
	applications of molecular markers in fisheries management and conservation.		
CLO2	Loss of fisheries biodiversity: Identifies the causes for the loss of fisheries biodiversity; Evaluate the Effects of environmental degradation on fisheries biodiversity; Analyzes the impact of aquaculture and hatcheries on wild fisheries. Loss of genetic diversity: Explains effects of inbreeding, genetic drift, founder effects and bottleneck and hybridization and gene introgression on fish populations; Explains methods of detection; Interprets genetic data of inbred and hybridized populations.	- Lectures followed by discussion - Participatory question-answer	
CLO3	Management and conservation of fisheries biodiversity: Proposes methods and strategies of fisheries biodiversity conservation; Designs and plans Genetical conservation of exploited fishes; Designs and plans for Returning local fish biodiversity; Bangladesh perspectives	- Lectures followed by discussion - Participatory question-answer	
CLO4	Measuring biodiversity: biodiversity indices (Shannon-Weiner index, Simpson Index, Margalef Index, Poulie's index and others). Biodiversity hotspots, Ramasar sites.	- Lectures followed by discussion - Participatory question-answer	
CLO5	Threatened biodiversity: Outlines fisheries biodiversity at global and country level; Knows IUCN and red data book; Applies criteria and categories for redlist of fish biodiversity; Outlines the red listed fish species and other fisheries items. Protected aquatic species.	- Lectures followed by discussion - Participatory question-answer	
CLO6	Assessment of changes and its factors: temporal and spatial changes in aquatic habitat and its biodiversity. Biological invasion and associated theories.	- Lectures followed by discussion - Participatory question-answer	

Recommended literature:

1. Gaston, K. J. and J. I. Spicer. 1998. Biodiversity - An Introduction. Wiley-Blackwell. 133 pp.
2. Helfman, G. E., B. B. Collette, D. E. Facey and B. W. Bowen. 2009. The Diversity of Fishes. Wiley-Blackwell.736 pp.
3. Patro, L. R. 2010. Aquatic Biodiversity, Discovery Publishing House Pvt. Ltd. 216 pp.
4. Genetics of Aquaculture and Fisheries Management. M. S. Shah. 1ST edition. Bangladesh.
5. Introduction to Conservation Genetics. R. Frankham, J. D. Ballou and D. A. Briscoe.

Cambridge University Press.
6. Conservation and the Genetics of Population. F. W. Allendorf and G. H. Luikart. Blackwell Publishing.
7. Population Genetics. M. B. Hamilton. Blackwell-Willey.
8. Ryman, N. and Utter, F (editors) 1987. Population Genetics and Fishery Management. Washington Sea Grant Program, University of Washington Press, Seattle and London.
9. Crow, J.F. and Kimura, M., 1970. An Introduction to Population Genetics Theory. Harper and Row Publishers, New York.
10. Chapman, B. (Editor), 1985. General and Quantitative Genetics. Elsevier Science Publishers, B.V. Amsterdam-Oxford-New York-Tokyo.
11. Hartl, D.L. and Clark, A.G., 1989. Principles of Population Genetics (2nd edition). Sinauer Associates, Sunderland, MA.
12. Hedrick, P.W., 1985. Genetics of Populations. Jones and Bartlett Publishers, Inc. Boston.
13. Kirby, L.T., 1990. DNA Fingerprinting: An Introduction. W.H. Freeman and Co. Saltlake City, UT. 5. Mayden, R.L. (Editor), 1993.
14. Systematics, Historical Ecology, and North American Freshwater Fishes. Stanford University Press, Stanford, USA.
15. Mustafa, G. 1999. Genetics in Sustainable Fisheries Management. Blackwell Science Ltd.
16. Roberts, D.F. and De Stefano, G.F. (Editor), 1986. Genetic Variation and its Maintenance. Cambridge University Press.
17. Soule, M.E. (Editor), 1987. Viable Populations for Conservation. Cambridge University Press.
18. Turner, B.J. (Editor), 1984. Evolutionary Genetics of Fishes. Plenum Press.
19. Whitemore D.H. (Editor) 1990. Electrophoretic and Isoelectric Focussing Techniques in Fisheries Management. CRC Press

0831-4205: Fish Inspection and Quality Control

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This course is a basic theoretical course and prerequisite to complete four years B.Sc. Fisheries (Honours) degree. The course coverers different aspects of fish inspection and quality control such as quality, quality program, quality organization, quality assessment and official inspection practices. A number of further topics, like food laws, HACCP, traceability, standard specification of fishery products and quality deterioration and defects in different fishery products. The course is designed to strengthen the student's existing knowledge on fish inspection and quality control system.

Learning Outcomes:

At the end of the course, the students will be able to- i) know the basic concepts of quality and quality control ii) know the application of modern approaches for quality control such as food laws,

HACCP, Traceability and specific standards etc., iii) determine the quality indicators in fish and fishery products iv) know the official inspection procedure in industry level.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Importance and problems of fish inspection and quality control program. Organization of fish inspection and quality control (FIQC), organizational structure, duties and responsibilities and inspection services of FIQC.	3
CLO2	Describe and apply food laws and regulations for fish and fishery products in Bangladesh; Outlines the EU and USFDA regulations and guidelines, International Commission of Microbiological Specification (ICMS), and Bangladesh Standard Testing Institute (BSTI).	2
CLO3	Describe and apply the quality management system in fish processing industry including good manufacturing practices (GMP), standard operating procedures (SOP) and sanitary sanitation standard operating procedures (SSOP).	3
CLO4	Apply and describe the HACCP system in fish processing industry	3
CLO5	Apply and describe the traceability systems in exportable fishery products of Bangladesh.	2
CLO6	Identify and explain the quality deterioration and defects in different fishery products	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course contents	Teaching Strategy	Assessment Strategy
CLO1	Importance and problems of fish inspection and quality control program. Organization of fish inspection and quality control (FIQC), organizational structure, duties and responsibilities and inspection services of FIQC.	- Lectures followed by discussion - Participatory question-answer	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	Laws and regulations for fish and fishery products in Bangladesh; EU and USFDA regulations and guidelines.International Commission of Microbiological Specification (ICMS), and Bangladesh Standard Testing	- Lectures followed by discussion - Participatory question-answer - Online resources	

CLOs	Course contents	Teaching Strategy	Assessment Strategy
	Institute (BSTI).		
CLO3	Quality management system in fish processing industry including good manufacturing practices (GMP), standard operating procedures (SOP) and sanitary sanitation standard operating procedures (SSOP).	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO4	HACCP system in fish processing industry.	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO5	Traceability systems in exportable fishery products of Bangladesh.	- Lectures followed by discussion - Participatory question-answer - Online resources	
CLO6	Quality deterioration and defects in different fishery products.	- Lectures followed by discussion - Participatory question-answer	

Recommended literature:

1. Control of Fish Quality. J. J. Connell (1980). Fishing News Books Ltd.
2. Safety and quality issues in fish processing, Edited by H. Allan Bremner. 2002, Woodhead Publishing Limited and CRC Press LLC
3. Fundamentals of Quality Control for the Food Industry. A. Kramer and B. A. Twigg (1966). The AVI Publ. Co. Inc. West port.
4. Processing of Aquatic Food Products. F. W. Wheaton and T. B. Lawson (1985). Wiley Inter Science. New York.
5. On Testing the Freshness of Frozen Fish. G. J. A. Peter (editor) (1971). Fishing News Books Ltd. London.
6. Harvests and Post-harvest Technology of Fish. K. Rabindran (editor) (1985). Society of Fisheries Technologists, India.
7. Industrial Fishery Technology. M. E. Stausby (1963). Reinhold Publ. Corp. New York.
8. Food authenticity and traceability Edited by MicheÁle Lees. 2003, Woodhead Publishing Limited and CRC Press LLC
9. Fish and Fishery Products Hazards and Controls Guidance Fourth Edition, 2011. U.S. Department of Health and Human Services Food and Drug Administration Center for Food Safety and Applied Nutrition (240) 402-2300
10. Technological Control in the Fish Processing Industry. G. V. Gerasimov and M. T. Antonova (1979). Amerind Publishing Co. Pvt. Ltd. New Delhi, Bombay, Calcutta, New York.

0831-4206: Fisheries Marketing

Credit: 2
Full Marks: 100 (Attendance: 10 + Class Test: 20 + Theory: 70)
Time: 3 hours (Six questions to be set and five to be answered)

Course Description:

This is a basic theoretical course and prerequisite for completing 4-year B.Sc. in Fisheries (Honours) degree. This course has been designed to enhance students' knowledge regarding the marketing of fish products including basic concepts and principles, marketing strategies, marketing channel and problems.

Learning Outcomes:

Upon completion of this course the students will be able to (i) understand core concepts of fish marketing and its importance in business and society; (ii) develop marketing strategies based on fish product, price, place and promotion objectives; (iii) communicate the unique marketing mixes and selling propositions for fish product offerings; and (iv) identify and solve problems in fish marketing.

At the end of the course the students would be able to-

CLOs	Course Learning Outcomes	Lectures
CLO1	Develop the basic concept of fish marketing. Explain levels and types of products and life cycle of product	5
CLO2	Explain product pricing, its strategies and methods. Explain and identify stakeholders involved in fish marketing. Promote a product.	7
CLO3	Perform market analysis.	4
CLO4	Explain and analyse marketing cost, margin, efficiency and management.	4
CLO5	Understand and explain international marketing.	4
CLO6	Identify and solve problems of fish marketing	4

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategies	Assessment Strategy
CLO1	Introduction: Definition and types of market; definition, importance, basic function, strategy and environments of marketing; marketing mix. Designing product: Definition, levels and types of products; product decisions, product line, product mix and product life cycle.	- Lectures followed by discussion	**Total (100)** Attendance: 10 In course Examination/ Tutorial/Quiz/ Class Test: 20 Final Examination: 70
CLO2	Pricing product: Definition, objective, factors and steps of pricing, pricing strategy, general pricing methods, price adjustment, fish pricing method. Placing product: Definition, qualities and types of marketing channel; types of middlemen, fish marketing channel; physical types and structure of fish market. Promoting products: Advertising, sales promotion, public relations and personal selling.	- Lectures followed by discussion	
CLO3	Market analysis: Market segmenting-bases, ways and evaluation; selecting market segment and choosing a market; market positioning; consumer buying behaviour-factors affecting consumer behaviour and types of buying behaviour; the buyer decision process.	- Lectures followed by discussion	
CLO4	Marketing cost, margin, efficiency and management: Importance, component and factors of marketing cost; types, component and estimation of marketing margin; form and increasing measures for marketing efficiency; different state of demand and management tasks.	- Lectures followed by discussion	
CLO5	International marketing: Definition, reasons for development, importance, features and environment of international marketing; export and import; document used in international marketing, channel structure, problem of international marketing.	- Lectures followed by discussion	
CLO6	Problems of fish marketing: Problems from growers, traders, processors and consumers point of view; mitigation measures of fish marketing problems.	- Lectures followed by discussion	

Recommended literature:

1. Srivastava and Uma Kant (1985) Inland Fish Marketing in India., IIM Ahmedabad & Concept Publishing Company, New Delhi.
2. Gupta VK (1984) Marine Fish Marketing in India. IIM Ahmedabad & Concept Publishing Company, New Delhi.
3. Le Blanch J (2003) The Global fish market and the need for multilateral fishing disciplines. In: Leonard B (Ed). Diane Publishing.
4. Bestor TC (2004) The fish market at the center of the world, In: Lilienthal PE. California studies, University of California Press.
5. Kotler PT and Armstrong G (2017) Principle of Marketing (17th edition)., Prentice Hall.
6. Kotler PT (2002) Management of Marketing (11th edition), Prentice Hall.
7. Acharya SS and Agarwal NL (1987) Agricultural Marketing in India (4th edition)., Oxford and IBH Publishing Company.

Practical Courses

0831-4211: Practical on Aquaculture Engineering and Farm Management

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Identify and determine the texture of soil.	1
CLO2	Evaluate the topography of proposed farm area.	2
CLO3	Draw and design of earthen and concrete pond; and fish farm.	3
CLO4	Draw and create structural design of shrimp and prawn hatchery.	3
CLO5	Estimate the cost of pond excavation and establish mini shrimp and prawn hatchery.	3
CLO6	Design water treatment plant for shrimp hatchery.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Determination of soil texture.	-Lecture -Demonstration	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Planes table and Contour survey.	- Lecture -Demonstration	
CLO3	Drawing and designing of earthen and concrete ponds; fish farm.	- Lecture - Field work -Lab work	
CLO4	Layout and structural designing of shrimp and prawn hatchery.	- Lecture - Field work -Lab work	
CLO5	Cost estimation of pond excavation and establishment of mini shrimp and prawn hatchery.	- Lecture - Field work -Lab work	
CLO6	Construction of water treatment plant for shrimp hatchery.	- Lecture -Demonstration	

0831-4212: Practical on Fish Health Management and Pharmacology

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Perform diagnostic techniques of fish disease	2
CLO2	Perform drug administration techniques	2
CLO3	Perform vaccination in aquaculture	2
CLO4	Exploit prevention and control of pathogenic fish diseases	2
CLO5	Calculate the drugs requited for controlling pathogenic diseases	2
CLO6	Exploit the prescription of drug	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Diagnostic techniques of fish disease	- Lectures followed by discussion - Field observation	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc)
CLO2	Drug administration techniques	- Lectures followed by discussion - Laboratory observation	
CLO3	Vaccination in aquaculture	- Lectures followed by discussion	
CLO4	Prevention and control of pathogenic fish diseases	- Lectures followed by discussion - Laboratory experiments	
CLO5	Calculate the drugs requited for controlling pathogenic diseases	- Lectures followed by discussion - Laboratory exercise	
CLO6	Prescription of drug	- Interview, direct observation and discussion	

0831-4213: Practical on Aquatic Pollution and Toxicology

Credit: 1
Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Measure and describe about different physical and chemical factors in polluted water	2
CLO2	Describe the technique of toxin analysis by HPLC and ELISA	2
CLO3	Explain bio-monitoring of aquatic pollution in freshwater ecosystem.	2
CLO4	Identify and explain heavy metals in polluted water and fish samples	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Collection and analysis of physico-chemical parameters from polluted water.	- Lectures - Field visit	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Analysis of toxins using HPLC and ELISA techniques.	- Lectures - Video demonstration	
CLO3	Bio-monitoring of aquatic pollution in freshwater ecosystem. Identification of heavy metals in polluted water and fish samples.	- Lectures - Field visit	
CLO4 CLO6	Techniques for waste treatments. Monitoring techniques and modeling systems for impact prediction.	- Lectures - Field visit	

0831-4214: Practical on Aquatic Biodiversity and Conservation

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Know and identify threatened and protected aquatic species.	2
CLO2	Know and explain conservation techniques for fish biodiversity.	2
CLO3	Know and explain conservation strategies of Bangladesh	3
CLO4	Measure changes in biodiversity.	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X

Lesson plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Study of threatened fishes of Bangladesh.	Lectures Problem solve	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Study of conservation techniques for fish biodiversity.	Lectures Problem solve	
CLO3	Fish biodiversity conservation strategies of Bangladesh.	Lectures Analyzing data	
CLO4	Field visit, literature review for determining changes in biodiversity.	Lectures Field survey Literature survey	

0831-4215: Practical on Fish Inspection and Quality Control

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Describe and demonstrate the organoleptic evaluation of fresh fish and fishery products	1
CLO2	Determine the total volatile base nitrogen (TVB-N) and peroxide value (PV) from fish sample.	1
CLO3	Enumerate the total viable count of bacteria and fungus.	1
CLO4	Enumerate the coliform and fecal coliform and Salmonella in fish and fishery products.	1
CLO5	Describe and prepare traceability in shrimp industry of Bangladesh.	1
CLO6	Demonstrate and describe the HACCP system.	1

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson Plan

CLOs	Course Contents	Teaching strategy	Assessment Strategy
CLO1	Organoleptic evaluation of fresh, chilled and frozen fish and shellfish Products	- Lectures followed by discussion - Participatory question-answer - Laboratory	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Determination of total volatile base nitrogen (TVB-N) and peroxide value (PV) from fish sample.	- Lectures - Laboratory Experiment	
CLO3	Enumeration of total viable count of bacteria and fungus.	- Lectures - Laboratory Experiment	
CLO4	Enumeration of coliform and fecal coliform and Salmonella in fish and fishery products	- Lectures - Laboratory - Experiment	
CLO5	Traceability in shrimp industry of Bangladesh	- Lectures - Laboratory	
CLO6	Group work and presentation about HACCP system	- Lectures - Group discussion - Presentation	

0831-4216: Practical on Fisheries Marketing

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Identify different fish products and their marketing channels and strategies	2
CLO2	Explain and identify value chain analysis and differentiate it from traditional marketing	2
CLO3	Develop fish product promotional messages	1
CLO4	Calculate marketing margin	1
CLO5	Identify problems of fish markets and recommend solutions	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
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

Lesson plan

CLOs	Course Contents	Teaching Strategies	Assessment Strategy
CLO1	Study of fish/fish product, fish/fish product pricing, fish/fish product placing (Middlemen and channel) and fish/fish product promotion in local fish markets.	- Lectures - Multimedia presentations - Question and answer	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Value chain analysis of fish and fisheries products	- Lectures - Paper discussion - Question and answer	
CLO3	Development of advertising messages for fish products.	- Lectures - Small group work - Question and answer	
CLO4	Calculation of marketing margin and producer's share in the consumer's payment	- Lectures - Example calculation	
CLO5	Visit to local fish markets report writing	- Field visit	

0831-4217: Practical on Participatory Rural Appraisal (PRA) Tools

Credit: 1

Full marks: 100 (Attendance: 10 + Class record/Report: 30 + Practical: 60)

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Exercise time line for an area or fisheries related activities or programmes	1
CLO2	Draw Venn diagram to establish the total picture of an area/village and it's relationships with different institutions,/organizations	3
CLO3	Draw seasonal diagram/calendar to determine seasonal patterns in rural areas	1

CLOs	Course Learning Outcomes	Lectures
CLO4	Rank preferences/choices of peoples in fisheries/aquaculture management	1
CLO5	Rank wealth of people to make different categories to be used as baseline information in fisheries research and extension.	1
CLO6	Produce social or household map for collating and plotting information on resources within the community	3

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X
CLO6	X	X	X	X	X

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Exercise of time line for an area or fisheries related activities or programmes	- Lecture followed by discussion - Participatory question-answer - Field visit - Presentation	**Full marks: 100** Attendance :10 Class record/Report:30 Practical: 60 (Experiment/ Dissection/ Calculation/ Presentation/ Spotting, etc.)
CLO2	Drawing Venn diagram to establish the total picture of an area/village and it's relationships with different institutions,/organizations	- Lecture followed by discussion - Participatory question-answer - Field visit - Presentation	
CLO3	Drawing seasonal diagram/calendar to determine seasonal patterns in rural areas	- Lecture followed by discussion - Participatory question-answer - Field visit - Presentation	
CLO4	Ranking preferences/choices of peoples in fisheries/aquaculture management	- Lecture followed by discussion	

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
		- Participatory question-answer - Field visit - Presentation	
CLO5	Ranking wealth of people to make different categories to be used as baseline information in fisheries research and extension.	- Lecture followed by discussion - Participatory question-answer - Field visit - Presentation	
CLO6	Producing social or household map for collating and plotting information on resources within the community	- Lecture followed by discussion - Participatory question-answer - Field visit - Presentation	

Internship Course

0831-4218: Internship (In-plant Attachment)

Credit: 3
Full Marks: 100 (Attendance 10 + Report 30 + Presentation 60)

Course Description:

This course is an internship course and prerequisite to complete four years B.Sc. Fisheries (Honours) degree. Students will be attached to different aspects of fisheries sector *viz.* hatcheries, processing industries/plants, fish feed industries, fish farms, upazila fisheries offices, district fisheries offices, BFRI, BFDC or relevant organizations individually or in a group for 1-3 months to acquire practical experience according to the prescribed datasheet approved by the academic committee. They will maintain the data sheet to record their daily observations along with the comment of the concern authority. After completion the task, students will give a presentation (60 marks) and submit a report (30 marks) at the date decided by the examination committee. Based on the performances in the place of attachment, student will also collect a certificate from the concern authority and submit it during viva-voce.

Expected Outcomes:

After completion of this course, the student would be able to operate/work in hatcheries, processing plants, fish feed industries, fish farms, upazila/district fisheries offices, BFRI, BFDC or relevant organization.

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

CLOs	Course Learning Outcomes	Lectures
CLO1	Identify different features of the organizations/institutes/industries	3
CLO2	Observe different activities of the organizations/institutes/industries	3
CLO3	Involve in the activities of the organizations/institutes/industries	6
CLO4	Record data based on the activities involved in the organizations/institutes/industries	2
CLO5	Develop presentation and report based on the collected data	2

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □ No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X
CLO2	X	X	X	X	X
CLO3	X	X	X	X	X
CLO4	X	X	X	X	X
CLO5	X	X	X	X	X

Lesson Plan

CLOs	Course Contents	Teaching Strategy	Assessment Strategy
CLO1	Identify different features of the organizations/institutes/industries	- Lecture followed by discussion - Participatory question-answer - Field visit - Presentation	**Full marks: 100** Attendance 10 Report 30 Presentation 60
CLO2	Observe different activities of the organizations/institutes/industries	- Lecture followed by discussion - Participatory question-answer - Field visit - Presentation	
CLO3	Involve in the activities of the organizations/institutes/industries	- Field visit - Presentation	
CLO4	Record data based on the activities involved in the organizations/institutes/industries	- Field visit - Presentation	
CLO5	Develop presentation and report based on the collected data	- Participatory question-answer - Presentation	

Viva-voce Course

0831-4221: Viva-voce

Credit: 1
Full marks: 100

Course Learning Outcomes (CLOs):

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

CLOs	Course Learning Outcomes	Sessions
CLO1	Communicate and express verbally the knowledge obtained in an effective and clear manner on Feed Manufacture and Live Feed Culture, Fisheries Resources Management, Fishery Byproducts Technology, Fish Stock Assessment, Fisheries Extension, Research Methodology, Aquaculture Engineering and Farm Management, Fish Health Management and Pharmacology, Aquatic Pollution and Toxicology, Aquatic Biodiversity and Conservation, Fish Inspection and Quality Control and Fisheries Marketing.	12

Mapping CLOs with PLOs (X, Strong contribution; ●, Weak contribution; □, No contribution)

CLOs	PLOs				
	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	X	X	X	X	X

Part D

20. Grading/Evaluation:

Distribution of semester activities:

Each semester will have 24 weeks distributed as follows:

- Classes/Lab/Field trip including class test : 14 weeks
- Exam preparatory recess : 2 weeks
- Semester final examination both theoretical and practical : 6 weeks
- Preparation and publication of results (semester interval) : 2 weeks

Marks distribution:

Each course, (theoretical, practical and viva-voce), irrespective of credit hours will be evaluated on 100 marks basis for the convenience of assigning letter grade and grade point.

The distribution of total marks for a given theoretical course will be as follows:

i) Class attendance / Participation : 10%
ii) Class test : 20%
iii) Final examination : 70%
Total : 100%

The distribution of total marks for a given practical course will be as follows:

i) Class attendance / Participation : 10%
ii) Continuous assessment (Lab record, Oral presentation) and/or Report : 30 %
iii) Practical Examination : 60%
Total : 100%

Marks for class attendance will be allotted on the basis of the following criteria:

Attendance* (%)	Marks
90 and above	10
85 to less than 90	9
80 to less than 85	8
75 to less than 80	7
70 to less than 75	6
65 to less than 70	5
60 to less than 65	4
Less than 60	0

* Percentage of attendance will be calculated in round figures. Fraction will be rounded up that means any fraction of total percentage of each course will be considered as next higher marks.

Class test: The class tests will normally take place at the end of 6th weeks of each semester. The course teacher will conduct class test according to the schedule declared by the Chairman of the concern department.

Class attendance: It will be recorded electronically in every class and finally be handed over to the chairman and will be preserved as examination record. The course teacher will also count the number of total classes, attended classes of each student and send to the chairman of the concern department.

A student with minimum 75% class attendance (regular) will be allowed to participate in the semester final examination. Candidates having less than 60% attendance will be decelerated as dis-collegiate and will not be allowed to fill up the examination form. Candidates having less than 75% to 60% attendance will be decelerated as non-collegiate and will be allowed to fill up the examination form with a fine of Tk. 1000/-.

Grading system:

A letter grade having a specified number of grade point will be awarded to each student for individual courses (sum of average marks of written examination, class attendance and class tests for theoretical and sum of continuous assessment (Lab record, Oral presentation) and/or Report and Practical examination) following conversion of numerical marks as shown below:

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 (D regular)	2.00
Less than 40%	F (Fail)	0.00

* Total marks of each course (theoretical, practical and viva-voce) will be calculated and rounded up (in case of fraction marks) by the tabulators. Rounded up means any fraction of total marks of each course will be considered as next higher marks.

Grade Point Average (GPA): The following formula will be used for calculation of semester GPA = $\frac{\sum(Gi \times Ci)}{\sum Ci}$

Where, ∑ = sum of, Gi = Grade point obtained in individual courses, Ci = Credit, of respective courses.

Cumulative Grade Point Average (CGPA): Cumulative Grade Point Average (CGPA), which is weighted average of the GPAs of a student in all concerned semesters, will be calculated as follows:

$$\text{CGPA} = \frac{\sum (GPAi \times TCi)}{\sum TCi}$$

Where, ∑ = sum of, GPAi = Grade Point Average obtained in individual semesters, TCi = Total Credits of respective semesters

GPA and CGPA will be calculated up to three and two decimal places respectively. In case of GPA, fourth decimal place will not be considered whereas for CGPA, if third decimal place remains 5 or above, the second decimal place will be calculated by adding 1 (one).

Award of degree: The degree of Bachelor of Science in Fisheries with Honours [B.Sc. Fisheries (Honours)] will be awarded on the basis of CGPA obtained by a candidate in B.Sc. Fisheries (Honours) semester (1^{st} year 1^{st} semester to 4^{th} year 2^{nd} semester) final examinations. The Examination Committee of B.Sc. Fisheries (Honours) 4^{th} year 2^{nd} semester will prepare the final result. In order, to qualify for the B. Sc. Fisheries (Honours) degree a candidate must have to obtain -

(i) a minimum CGPA of 2.50,

(ii) a minimum GPA of 2.00, 2.25, 2.50, 2.50 in each of 1^{st} and 2^{nd} semester of 1^{st}, 2^{nd}, 3^{rd} and 4^{th} years examinations respectively.

(iii) Total credit point (TCP) must be earned by a student.

Promotions: In order to be eligible for promotion from one semester to the next higher semester, a candidate must secure - at least 2.00, 2.25, 2.50, 2.50 GPA in each of his/her 1^{st} and 2^{nd} semester of 1^{st}, 2^{nd}, 3^{rd} and 4^{th} years final examinations, respectively. A student who has obtained F grade in maximum two theoretical courses in each semester may be allowed to register for courses in the next semester. He/she must clear F grade within the immediate next two concern semester final examination after the publication of results within 6 academic years according to his/her syllabus.

Course Improvement in 1^{st} and 2^{nd} semester of the year 1^{st} – 3^{rd} and 1^{st} semester of 4^{th} year: A promoted student earning a grade less than 2.75 (B minus) in individual theoretical courses will be allowed as regular students to improve the grades on courses (not more than two courses (up to 6 credits) including F grade) of their each semester final examinations to improve their grade within the immediate next concern semester final examination often the publication of results within 6 academic years according to his/her curriculum assigned for one time. To clear F grade the candidate will be allowed to appear in the examination for maximum two times in immediate consecutive similar semesters within 6 academic years according to his/her curriculum assigned. If a promoted student will not be able to improve his/her GP in individual courses, the previous GP will be remaining valid.

No improvement (including F clear) will be allowed in practical, viva-voce and incourse works (attendance / class test / class assessment / tutorial / terminal assessment / field report / excursion / home assignments etc.).

Final Result (CGPA) Improvement in 2nd semester of the year 4 (final year):

A promoted student earning a grade less than 3.00 (B regular) in individual theoretical courses will be allowed as irregular students to improve the grades on courses (not more than two courses (maximum 6 credits) including F grade) of their each final semester examinations within the immediate next concern semester final examination often the publication of results within 6 academic years according to his/her curriculum assigned for one time. To clear F grade the candidate will be allowed to appear in the examination for maximum two times in immediate consecutive similar semesters within 6 academic years according to his/her curriculum assigned. If a candidate fails to improve their Grade, the previous grade will remain valid. He / she will be treated as irregular student.

No improvement (including F clear) will be allowed in practical, viva-voce and incourse works such as - attendance / class test /class assessment / tutorial / terminal assessment / Field report / excursion / home assignments etc.

Dropping out: Candidates failing to earn the required GPA after completing regular semester examinations and subsequently failed again after taking readmission in concerned semester will be dropped out of the programme.

Withdrawal from a semester:

If a candidate completes his/her course work (including incourse) but fails to fill-up examination form or fails to appear the examination or fails to earn minimum GPA for promotion to the next semester, his/her previous course works (including incourse) will be invalid. And he/she must carry out all course works based on his/her assigned curriculum with immediate next 2 semesters within 6 academic years.