Department of Fisheries
Faculty of Fisheries

Curriculum
for
M. Phil. and Ph.D. Courses
Session: 2023-2024

University of Rajshahi
Rajshahi, Bangladesh

UNIVERSITY OF RAJSHAHI
DEPARTMENT OF FISHERIES
FACULTY OF FISHERIES

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Overview

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. 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.

Vision of M. Phil. and Ph.D. Courses

Academic and need-based research excellence in fisheries sector.

Mission of M. Phil. and Ph.D. Courses

M1: To achieve academic and research excellence in fisheries sector through state-of-the-art infrastructure and skilled academics.

M2: To produce globally competitive fisheries scientists who are capable of creating innovative techniques that will ultimately help in increasing fisheries production and ensure safe food for people.

Program Educational Objectives (PEOs) of M. Phil. and Ph.D. Courses

PEO1: To conduct advanced and applied research in different aspects of fisheries biology and genetics,aquaculture, fisheries management and fisheries technology.

PEO2: To disseminate research findings available for research community and stakeholders.

Mapping between Mission and PEO

Mission	Program Educational Objectives (PEOs)	
	PEO1	PEO2
M1	**X**	●
M2	**X**	●

X Strong contribution ● Weak contribution ☐ No contribution

At the end of the M. Phil. and Ph.D. Courses, the graduates will be able to-

POs	Program Outcomes (POs)
PO1	Apply appropriate research methods, statistical tests, information technologies in scientific studies in fisheries science.
PO2	Develop skills in oral and written presentations of biological research in popularscientific and academic context

Mapping between PEO and PO

PEOs	Program Outcomes (POs)	
	PO1	PO2
PEO1	**X**	●
PEO2	●	**X**

X Strong contribution ● Weak contribution ☐ No contribution

The M. Phil. and Ph.D. courses shall consist of one compulsory and two optional courses considering research field covering a total of300 marks and 6 credits (100 marks and 2 credits for each course). The students will complete the course work with in the first year of their admission obtaining satisfactory marks in both compulsory and optional courses relevant to his research work.

DETAILED BREAKS UP OF COURSES

Detailed breaks up of courses

Courses	**Full Marks**
Compulsory	
MPC-801: Biostatistics and Research Methodology	100
Optional (Any two)	
MPO-802: Advanced Ichthyology	100
MPO-803: Reproductive Biology and Behaviour of Fishes	100
MPO-804: Fish Genetic Engineering and Biotechnology	100
MPO-805: Advanced Fish Physiology	100
MPO-806: Fisheries Systematics and Evolution	100
MPO-807: Fish Population and Conservation Genetics	100
MPO-808: Advanced Freshwater Aquaculture	100
MPO-809: Advanced Coastal and Marine Aquaculture	100
MPO-810: Advanced Fish Nutrition	100
MPO-811: Fish Disease and Health Management	100
MPO-812: Fish Farming Systems	100
MPO-813: Advanced Livelihood in Fisheries	100
MPO-814: Fisheries Resources	100
MPO-815: Aquatic Environment and Pollution	100
MPO-816: Inland Fisheries Management	100
MPO-817: Coastal and Marine Fisheries Management	100
MPO-818: Advanced Fish Population Dynamics	100
MPO-819: Fisheries Impact Assessment	100
MPO-820: Modern Fishing Technology	100
MPO-821: Fish Processing and Preservation Technology	100
MPO-822: Advanced Fisheries Microbiology and Microbial Technique	100
MPO-823: Fishery Products and Quality Control	100
MPO-824: Modern Fish Feed Technology	100
MPO-825: Fishery By-products Technology	100
	Total: 300

COMPULSORY COURSE

MPC-801: Biostatistics and Research Methodology
Full Marks: 100; Credit: 2

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. In addition, techniques and standards of thesis and manuscript writing will also be discussed.

Course Objectives:
To provide students with the knowledge of statistics type and its scope, population and sample, correlation and regression, test of hypothesis, designing research, thesis writing and drafting scientific papers and its publication.

Learning Outcomes:
By the end of the course, students should be able to (i) describe importance and scope of the biostatistics, (ii) estimate correlation and regression (iii) perform testing of hypothesis regarding population mean, and equality of two means.(iv) identify research problems (iv) design, collection and analyze qualitative and quantitative data. (v) employ appropriate statistical methods for data analysis; and (vi) prepare and publish scientific paper.

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

COs	Course Outcomes	Lectures
CO1	Define the Statistics, Biostatistics and its classification and application to fisheries and aquaculture research.	1
CO2	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.	1
CO3	Describe the 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 and its uses in fisheries and aquaculture research.	1
CO4	Identify research problems and gaps	1
CO5	Describe appropriate data collection methods and their analyses	1
CO6	Apply appropriate research design with data analysis techniques	1
CO7	Know about concept and different types and steps involved in biological research	1
CO8	Know and write thesis, scientific papers and other publications	1
CO9	Know and use computer software in biological research	1

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	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	Full Marks:100

CO2	Correlation and Regression: Simple correlation, linear regression, useful theorem in correlation and regression, relationship between co-efficient of correlation and regression co-efficient, residual error, standard error of regression co-efficient.	-Lectures followed by discussion -Participatory question-answer	
CO3	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	
CO4	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 -Participatory question-answer	
CO5	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.	-Lectures followed by discussion -Participatory question-answer	
CO6	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.	-Lectures followed by discussion -Participatory question-answer	
CO7	Concept and types of research, different steps of conducting research.	-Lectures followed by discussion -Participatory question-answer	
CO8	Thesis and scientific paper writing and publication: Introduction, materials and methods, results and observations, review of literature and references.	-Lectures followed by discussion -Participatory question-answer	
CO9	Computer and its application in research: introduction of computers, data input and analysis, use of various software.	-Lectures followed by discussion -Participatory question-answer	

Recommended books/literature:

1. Introduction to Biostatistics. H. Bancroft (1957). Hoeber-Herper. New York.
2. Statistical Methods and Scientific Inference. R. A. Fisher (1956). Oliver, Edinberg.
3. Introduction to Probability and Statistics. (6th edn). H. Alder (1977). San Francism, Freeman.
4. Biostatistics, An Introductory Text. A. Goldstein (1968). MacMillan, New York.
5. Biostatistics. A. Lewis (1971). East West Press, New Delhi.
6. Methods of Statistics. 2nd edn. M. G. Mostafa. Anwari Publ. Dhaka.
7. Biostatistical Analysis. J. H. Zar (1999). Prentice and Hall Inc. Englewood Cliffs, New Jersey.
8. Statistical Procedures for Agricultural Research. K. Gomez and A. A. Gomez (1984). 2nd edn. John Wiley and Sons. Inc. New York.
9. Fundamentals of Statistical Theory Vol. I. 2,3. A. M. Goon, M. K. Gupta and D. Gupta (1979). World Press Pvt. Ltd. Calcutta, India.
10. Methods of Statistical Analysis. G, H. Goulden (1952). John Wiley, New York.
11. Elementary Statistics. 2nd edn. R. R. Johnson (1976). Duxberg Press, Massachusetts.
12. How to write and publish a scientific paper, Robert A. Day (1996). Cambridge University Press, Canada.
13. Writing your thesis, Paul Oliver (2006), Vistaar Publications, New Delhi.

OPTIONAL COURSES

MPO-802: Advanced Ichthyology
Full Marks: 100; Credit: 2

Course Description:
The course covers external and internal morphology of fishes *viz*. integumentary, circulatory, respiratory, excretory, osmo-regulatory, and reproductive &urinogenital system of fishes along withmorphology of skeletal, muscular, digestive, endocrine and nervous system in 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.

Course Objectives:
To provide students with the knowledge of fishmorphology especially body forms and organ systems.

Learning 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) know the basic structure and function of major organ systems of fish; iv) explain the structure and function of some special organs of fish; v) apply acquired knowledge in all aspects of studying fishery science.

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

COs	Course Outcomes	Lectures
CO1	Describe the history behind Ichthyology and explain its importance.	1
CO2	Compare and identify various external forms and features of fish body along with appendages.	1
CO3	Differentiate structural variation, function and derivatives of associated organs related to external morphology.	1
CO4	Demonstrate and compare types, structure and mode of blood circulatory system.	1
CO5	Compare and explain the structure and function of respiratory organs in different fish groups.	1
CO6	Explain the structure and function of excretory and osmo-regulatory system along with mode of action.	1
CO7	Apply acquired knowledge of reproductive and urinogenital system in practical field as well as operation a fish farm.	1
CO8	Explain and distinguish development of bone and variation in their structural modification in formation of skeletal system of fish.	1
CO9	Explain the structure and function of musculature; and distinguish their association with the skeletal system.	1
CO10	Differentiate structure, function and variation in digestive system in different fish groups and associated glands related to digestion.	1
CO11	Explain the structure and function of endocrine glands, evaluate their mode of action and hormone secretion.	1
CO12	Explain the structure and function of nervous system with mode of action.	1
CO13	Explain the structure of different receptor organs in fishes and their mode of action.	1
CO14	Understand mode of action of special organs in adaptive radiation in fishes.	1

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	History and importance of Ichthyology.	Lecture followed by discussion	Full Marks:100
CO2	External morphology: body form, body coverings, appendages and openings.	Lecture followed by discussion	

CO3	Integumentary System: structure and function of skin; scales- structure, shape, types, derivatives, functions; other derivatives of skin- glands, dermal fin rays, flaps and barbels; colouration- colour patterns, sources of colour, functions of colouration in fishes.	Lecture followed by discussion	
CO4	Circulatory system: definition, branchial and pulmonary circulation, afferent and efferent branchial systems, open and closed circulation; lymph and lymphatic system.	Lecture followed by discussion	
CO5	Respiratory system: Gills and air-breathing organs and structure of respiratory organs.	Lecture followed by discussion	
CO6	Excretory and osmo-regulatory system: Classification, structures and functions.	Lecture followed by discussion	
CO7	Reproductive and urinogenital system: definition, types and sexual dimorphism	Lecture followed by discussion	
CO8	**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	
CO9	**Muscular System:** classification and muscle terminologies – skeletal muscles in head, trunk and tail, branchial musculature, eye muscles, median and paired fin musculatures, smooth muscles and cardiac muscles.	Lecture followed by discussion	
CO10	**Digestive system:** definition, alimentary tracts and modification and digestive glands.	Lecture followed by discussion	
CO11	**Endocrine system:** Type, origin, hormone secretion and action.	Lecture followed by discussion	
CO12	**Nervous system:** classification, brain and spinal cord, cranial and spinal nerves and autonomic nervous system.	Lecture followed by discussion	
CO13	**Receptor organs:** classification, structures and functions of important receptors.	Lecture followed by discussion	
CO14	Adaptive radiation in fishes with reference to special organs viz. poison glands, light organs, electric organs etc.	Lecture followed by discussion	

Recommended books/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. Datta Munshi and G. M. Hughes (1992), Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, Bombay, Calcutta.

MPO-803: Reproductive Biology and Behaviour of Fishes
Full Marks: 100; Credit: 2

Course Description:
The course is designed to expand students' knowledge on reproductive aspects of commercially important fish species of Bangladesh. It basically covers the reproductive biology of carps, catfishes, hilsa, snakeheads, ornamental fishes, eel, shark, marine finfish and other fishes with emphasis on reproductive periodicity, fecundity, maturation stages of gonad, gonadal length index and gonado-somatic index. The course also covers different behaviours of aquatic organisms with special reference to animal personality with a view to understanding the biology and ecology of fishes.

Course Objectives:
To provide students with the knowledge of structure and physiology of major reproductive organ systems of fish along with different fish behaviours including personality, feeding, migratory, social and reproductive behaviours and their significance.

Learning Outcomes:
At the end of the course, the students will be able to- i) obtain proper knowledge on reproductive biology of fresh and marine water fish; ii) obtain proper knowledge on reproductive periodicity of fish iii) estimate and relate fecundity, gonadal measures with various body parameters iv) understand the importance of various fish behaviour, and v) apply acquired knowledge in management and conservation of farm and wild fish population.

At the end of the course the students would be able to-

COs	Course Outcomes	Lectures
CO1	Explain the background of studying reproductive biology of fishes.	1
CO2	Understand and apply the knowledge of reproductive biology in management and conservation of fresh and marine water fish species.	1
CO3	Understand the reproductive periodicity and apply knowledge in management of farm and wild fish population.	1
CO4	Understand the methods of fecundity estimation and apply knowledge in management of wild fish population.	1
CO5	Differentiate the maturation stages of fish and apply knowledge in management fish farm.	1
CO6	Relate gonadal length and weight among body length and weight and apply knowledge in management and conservation of fish population.	1
CO7	Develop the basic concept of fish behaviour and explain its significance in fisheries science (specially aquaculture, fisheries management and harvest technology).	1
CO8	Understand and explain different types of fish behaviours along with their mechanisms and theories.	1
CO9	Explain the feeding behaviours of fishes and effectively suggest / employ this knowledge in aquaculture, open water management and species conservation activities.	1
CO10	Explain the reproductive behaviours of various important fishes and effectively suggest /employ this knowledge in managing any stock.	1
CO11	Explain the significance of migratory behaviours of fishes and effectively suggest / employ this knowledge in managing any stock.	1

CO12	Explain the significance of parental care of fishes and effectively suggest / employ this knowledge in managing any stock.	1
CO13	Explain special behaviours of fishes (e.g. aestivation and hibernation) and effectively explain or employ this knowledge in managing any stock.	1

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	Introduction, rationale and expected outcome.	Lecture followed by discussion	Full Marks:100
CO2	Reproductive biology of some important fishes: carps, catfishes, hilsa, snakeheads, ornamental fishes, eel, shark, marine finfish and other fishes.	Lecture followed by discussion	
CO3	Reproductive periodicity in fishes.	Lecture followed by discussion	
CO4	Estimation of the fecundity of fishes.	Lecture followed by discussion	
CO5	Maturation stages of ova and gonad.	Lecture followed by discussion	
CO6	Gonadal length index &gonado-somatic index.	Lecture followed by discussion	
CO7	Basic terminologies of animal behaviour	Lecture followed by discussion	
CO8	Kinds, mechanism and theories of behaviour	Lecture followed by discussion	
CO9	Feeding behaviour of fishes	Lecture followed by discussion	
CO10	Reproductive behaviour of different species	Lecture followed by discussion	
CO11	Migratory behaviour of fishes	Lecture followed by discussion	
CO12	Parental care of fishes	Lecture followed by discussion	
CO13	Special behaviours in fishes	Lecture followed by discussion	

Recommended books/literature:

1. Bone Q and Moore RH (2008) Biology of Fishes, third edition. Taylor & Francis, USA and UK.
2. Kumar S and Tembhre M (1996) Anatomy and Physiology of Fishes. Vikas Publishing House Pvt Ltd, India.
3. Lagler KF, Bardach JE, Miller RR and Passino (1977) Ichthyology, second edition. John Wiley & Sons. New York, USA.
4. Shammi QJ and Bhatnagar S (2002) Applied Fisheries. Agrobios, India.
5. Yadav BN (1997) Fish and Fisheries. Daya Publishing House, India.
6. The Diversity of Fishes, GS Halfman, BB Collette and DE Facey (2000) Blackwell Science, USA
7. Modern Textbook of Zoology: Verebrates (2nd ed.), R.L. Kotpal (2000) NewDelhi, India.
8. Text Book of Zoology, Vol. II), T. G. Parker and W. S. Haswell (1960), McMillan Co. Ltd., London.
9. General Zoology, T. I. Storer and R. L. Usinger (1965), McGraw Hill Book Co., New York.
10. The Life of Vertebrates, J. Z. Young (1962), Oxford Univ. Press, London.

MPO-804: Fish Genetic Engineering and Biotechnology
Full Marks: 100; Credit: 2

Course Description:

This course is aimed to provide knowledge and understanding genetic engineering, recombinant DNA technology, gene manipulation and genetic transformation and their application to plant, animal and microbes improvement and their conservation.This course presents an overview of the research and commercial applications, and issues/challenges in the area of Genetic Engineering. They will be able to know biosafety and risk management related to genetically modified fish and shellfish. Moreover, they will gather the knowledge to produce mutational aquatic animals for aquarium culture. The course also provides students with methodologies for the current technologies used for genetic improvement of fish and shellfish aquaculture and wild fishery resource management. The course is designed to familiarize the students with practical use of genetic markers in selection and hybridization of fishes. This course is also aimed to know different biotechnological approaches; to produce different value added products and bi-products, to know different diseases of fish and shellfish and health management in farmed fishes and wild fisheries management.

Course Objectives:

To provide students with the knowledge on the modern genetic engineering and biotechnological techniques used in fisheries and aquaculture as well as to describe monosex, inbred, gynogen, androgen, and marine products with their application and limitations.

Learning Outcomes:

At the end of the course, the students will be able to describe recombinant DNA techniques, DNA cloning, transgenic technology in fisheries and aquaculture and biosafety of these techniques.

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

COs	Course Outcomes	Lectures
CO1	Describe basic concept and prospect of genetic engineering technology in fisheries and aquaculture.	1
CO2	Describe recombinant DNA techniques used in aquatic animals focusing on selection of gene of interest, enzymes commonly used in these technology and formation of DNA constructs.	1
CO3	Describe DNA extraction and purification techniques from fish tissue and nucleic acid hybridization processes used in fisheries and aquaculture.	1
CO4	Describe DNA cloning techniques used in fisheries and aquaculture.	1
CO5	Describe Gene expression, isolation and cloning for different purpose in fisheries and aquaculture.	1
CO6	Describe transgene transfer techniques and their integration, transmission and expression in fishes; Describe reporter genes with their properties and application.	1
CO7	Describe effects of transgene in fish and shellfish and environment.	1
CO8	Describe risk assessment of transgenic with emphasis on biosafety regulations, food safety and ethical issues.	1
CO9	Describe biotechnology in fish health management.	1
CO10	Describe and design genetic improvement program for commercial aquaculture fishes using different selective breeding.	1
CO11	Explain and design inbreeding program for inbred and clonal lines production; Describe and design crossbreeding and hybridization program for Indian and Chinese carps.	1
CO12	Explain and produce gynogens and androgens for aquaculture and fisheries management.	1
CO13	Explain and produce sex reversed and monosex fish population using different techniques.	1
CO14	Describe polyploidy production and their performance in fisheries and aquaculture.	
CO15	Describe commercial application of fish biotechnology, genetic engineering and other technology.	
CO16	Describe environmental biotechnology with emphasis on risks of aquatic organisms from genetic biotechnology and engineering.	
CO17	Describe constrains and limitations of genetic biotechnology, especially of research; development, biodiversity, political and economic issues.	
CO18	Describe marine Biotechnology: Marine natural products; physiology of marine organisms; \a source of metabolites; Seeweeds; sponges;	

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	Introduction: Prospects for genetic engineering in fishes. Fish as model animals for genetic engineering and biotechnology. An overview of genes cloned from fishes.	Lecture followed by discussion	Full Marks:100

CO2	Recombinant DNA techniques: Selection of a gene of interest; Enzymes commonly used in DNA technology; Restriction endonucleases-Major classes and nomenclature; Ligase enzyme; Reverse transcriptase; kinase enzyme, DNA polymerase, maring of DNA constructs.	Lecture followed by discussion	
CO3	DNA extraction and purification: Isolation of total cellular DNA; Nucleic acid hybridization-Northern blotting; southern blotting; Western blotting; molecular hybridization; Labelling of nucleic acids.	Lecture followed by discussion	
CO4	DNA cloning: Selection of suitable vector (plasmids); cutting DNA at precise location; joining two prices of DNA. Transformation, amplification of DNA, selection of the hosts expressing recombinant DNA. Isolation of target DNA for the host cells.	Lecture followed by discussion	
CO5	Gene expression, isolation and cloning: Gene expression and expressed sequence tags (ESTs); growth, ovulation and reproduction, diseases, brain, cold tolerance, osmoregulation, genetic imprinting and parental predominance, transposable elements, ribosomes and proteomics.	Lecture followed by discussion	
CO6	Gene transfer technology: Selection of fish species; Transgene; mitochondrial DNA in gene transfer; Promoters; Collection of germ cells or embryos; Gene transfer techniques; Manipulating embryonic stem cells; Transgene Integration; transmission of transgenes; transgene expression; Reporter genes-properties and application.	Lecture followed by discussion	
CO7	Transgenic fish and shellfish: Gene transfer for growth-hormone and AFP genes; performance of transgenic fish; transgenic production of pharmaceuticals; gene knockout technology, and potential role.	Lecture followed by discussion	
CO8	Bio-safety: Risk assessment for transgenic; GMOs and biosafety regulations, food safety of transgenic aquatic organisms; ethical issues of GMOs; National regulation of GMOs.	Lecture followed by discussion	
CO9	Biotechnology in health management: Monoclonal antibodies; Immunotoxin; Vaccines; Nucleic acid probes;	Lecture followed by discussion	
CO10	Selective breeding: Selection based on gene of known large effect: QTL and MAS; Breeding values for binary traits; Selection and breeding for disease resistance and survival analysis; Partial diallele analysis; Selection for single trait and multiple traits; Genetic improvement program for tilapia (GIFT), common carp, atlantic salmon and thaipangus, sharpunti; correlations;	Lecture followed by discussion	

CO11	Inbreeding and hybridization: Production of clonal lines; genetics of hybridization; Natural and artificial hybridization; Hybridization in Indian and Chinese carps;	Lecture followed by discussion	
CO12	Gynogenesis and androgenesis: induction and performances of gynogens and androgens, reproduction; inbred productions.	Lecture followed by discussion	
CO13	Sex reversal and breeding: Sexual dichromatism; chemical and mechanical sex reversal and breeding in all-female XX systems, all-male ZZ systems, and all male YY systems; Social induction.	Lecture followed by discussion	
CO14	Polyploidy: Polyploid induction in fish and shellfish, triploid cells, ploidy determination; performances of triploid fish and invertebrates, tetraploid fish and shellfish, and hexaploid fish	Lecture followed by discussion	
CO15	Commercial application of fish biotechnology: polyploidy, sex reversal and breeding and genetic engineering; surrogation technology; probiotics in aquaculture; cryopreservation technology.	Lecture followed by discussion	
CO16	Environmental biotechnology: Environmental risks of aquatic organisms from genetic biotechnology-Theoretical risks, environmental risk data on transgenic fish and genetic sterilization.	Lecture followed by discussion	
CO17	Constrains and limitations of genetic biotechnology: Research issues; general recommendations; development issues; biodiversity issues; political issues; and economic issues.	Lecture followed by discussion	
CO18	Marine Biotechnology: Marine natural products; physiology of marine organisms; source of metabolites; Seeweeds; sponges.	Lecture followed by discussion	

Recommended books/literature:

1. Dunham RA (2004) Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI Publishing UK.
2. Gupta PK (1998) Cytology Genetics and Molecular Biology. Rastagi Publications, India.
3. Ranga MM and Shammi QJ (2005) Fish Biotechnology. Agrobios, India.
4. Shah MS (2010) Genetics of Aquaculture and Fisheries Management, first edition. Published by MrsZinnatunAra Shah, Khulna, Bangladesh.
5. Tave D (1993) Genetics for Fish Hatchery Manager, second edition. AVI Book. New York, USA.
6. A. R. Beaumont and K. Hoare (2003). Biotechnology and Genetics in Fisheries and Aquaculture. Blackwell Publishing.
7. Carl A. Pinkert. Transgenic Animal Technology: A Laboratory Handbook.
8. V.S.Kirpichnikov. Genetic bases of fish selection.
9. W. S. Lakra and Gopakrishnan. Genetics, genetic engineering and Biotechnology in fisheries.
10. Genetics and Fish Breeding: C.E.Purdom.

MPO-805: Advanced Fish Physiology
Full Marks: 100; Credit: 2

Course Description:
This coursedescribes 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.

Course Objectives:
To provide students with the advance knowledge of fish temperature regulations, digestions, metabolism, respiration, excretion and osmoregulation.

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-

COs	Course Outcomes	Lectures
CO1	Define the physiology, anatomy and classify the fishes based on thermal regulation including homeotherms, poikilotherms and endotherms.	2
CO2	Describe the digestion, digestion mechanism, digestive secretion (function of HCl and role of bile), sources of enzymes and its function, absorption and assimilation.	2
CO3	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.	2
CO4	Describe the physiology of respiration, transport and exchange of gases, factors affecting O_2 and hemoglobin affinity, respiratory volume and respiratory quotient of fishes.	2
CO5	Know the excretory products, biochemical composition of excretory products and physiology of excretion.	2
CO6	Discuss the Osmosis, osmotic pressure, isotonic, hypotonic, hypertonic, uryhaline, stenohaline, electrolytes, osmoregulation in freshwater, marine and migratory fishes.	2
CO7	Know the concept of age and growth and its estimation methods and factors affecting on it.	3
CO8	Describe the composition and function of blood, mechanism and physiology of blood circulation, heart structure, myocardial electrical activity, cardiac flow and heart volume.	2
CO9	Know the hormone secretion and their role in the life process of fishes and its application to breeding purposes.	2
CO10	Describe the physiology of reproduction, classification, Ovarian maturation stages, sexual maturity and reproductive cycle.	3

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	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	Full Marks: 100
CO2	Digestion: Concept of digestion, digestion mechanism, digestive secretion (function of HCl and role of bile), sources of enzymes and function, absorption and assimilation	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO3	Metabolism: Concept of metabolism, phases of metabolism: anabolism and catabolism, classification of metabolic rate based on activity levels, water and solute metabolism,	-Lectures followed by discussion -Participatory question-answer -Online resources	

	cellular metabolism, factors controlling metabolism in fish.		
CO4	Respiration: Definition, physiology of respiration, transport and exchange of gases, factors affecting O_2 and hemoglobin affinity, respiratory volume, respiratory quotient.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO5	Excretion: Definition and concept on excretory products, biochemical composition of excretory products, physiology of excretion.	-Lectures followed by discussion -Participatory question-answer -Online resources -Video demonstration	
CO6	Osmoregulation: Osmosis, osmotic pressure, isotonic, hypotonic, hypertonic, uryhaline, stenohaline, electrolytes, osmoregulation in freshwater, marine and migratory fishes.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO7	Growth: Definition and general concept of age and growth, methods for estimation of age and growth, and factors affecting growth.	-Lectures followed by discussion -Participatory question-answer	
CO8	Blood circulation: Composition and function of blood, mechanism and physiology of blood circulation, heart structure, myocardial electrical activity, cardiac flow, heart volume.	-Lectures followed by discussion -Participatory question-answer	
CO9	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	
CO10	Reproduction: Physiology of reproduction, classification of reproductive strategies, Ovarian maturation stages, sexual maturity and reproductive cycle.	-Lectures followed by discussion -Participatory question-answer	

Recommended books/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 History 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 (2^{nd}ed) by Pandey, Shukla (2007).Rakesh Kumar Rastogi Publications, Shivaji Road, Meerut, India.

MPO-806: Fisheries Systematics and Evolution

Full Marks: 100; Credit: 2

Course Description:

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 and evolution. 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 also be focused.

Course Objectives:

To provide advance knowledge to the students on taxonomy, systematics, origin and evolution and zoological nomenclature of fish.

Learning Outcomes:

At the end of the course, the students will be able to: i) know 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 -

COs	Course Outcomes	Lectures
CO1	Know the history of biological taxonomy and systematics.	2
CO2	Identify, measure or count the taxonomic characteristics in fishes.	3
CO3	Discuss about the taxonomic collection, labeling, preservation, curation and cataloguing of fish and other fisheries items.	3
CO4	Apply to identify of fishes using taxonomic keys and other methods.	2
CO5	Discuss types, theories, categories and basis of classification.	2
CO6	Know zoological nomenclature, synonyms, synonymy, law of priority, the type method.	4
CO7	Know species concept and speciation.	4
CO8	Know origin and evolution of fishes.	4

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	History of biological taxonomy and systematics.	-Lectures followed by discussion -Participatory question-answer	Full Marks: 100
O2	Taxonomic characteristics: types, measurement, counting special reference to fishes and shellfishes.	-Lectures followed by discussion -Participatory question-answer	
CO3	Taxonomic collection, labeling, preservation and curation and cataloguing of fish and other fisheries items.	-Lectures followed by discussion -Participatory question-answer	
CO4	Identification of fishes using taxonomic keys and other methods.	-Lectures followed by discussion -Participatory question-answer	
CO5	Types, theories, categories and basis of classification.	-Lectures followed by discussion -Participatory question-answer	
CO6	Zoological nomenclature, synonyms, synonymy, law of priority, the type method.	-Lectures followed by discussion -Participatory question-answer	
CO7	Species concept and speciation	-Lectures followed by discussion -Participatory question-answer	
CO8	Origin and evolution of fishes.	-Lectures followed by discussion -Participatory question-answer	

Recommended books/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.

MPO-807: Fish Population and Conservation
Full Marks: 100; Credit: 2

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. The course coverers managements techniques of inland water fisheries, creation of new fish habitats in inland water, existing problems in inland fisheries and their solutions, national policy and programmes for inland fisheries management and ecosystem conservation issues.

Course Objectives:
To provide students with the concepts of population genetics for management and conservation of aquatic animals.

Learning Outcomes:
At the end of the course, the students will be able to explain concepts of populations and its structure for fisheries management and conservation.

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

COs	Course Outcomes	Lectures
CO1	Define population and conservation genetics and describe their application. Describe importance, estimation, causes of loss and influencing factors of genetic diversity.	1
CO2	Explain population genetic theories and principles with their applications and deviations.	2
CO3	Explain genetic drift with their causes and the factors affecting it.	2
CO4	Describe types, methods of estimation and consequences of inbreeding in fish populations.	2
CO5	Explain basic concept of population connectivity and structure with measure of coefficient of genetic differentiation.	2
CO6	Explain genome mapping, DNA fingerprinting and sequencing with their applications.	2
CO7	Explain general principles and applications of taxonomic, biochemical and molecular tools in stock composition analyses.	2
CO8	Describe mitochondrial DNA with its inheritance and applications for determining fish population structure.	2
CO9	Explain genetic aspects of endangered populations as per guidelines of IUCN.	2
CO10	Describe present status and causes of loss fish genetic diversity in Bangladesh	2
CO11	Describe methods and techniques of conservation and preservation of aquatic species.	2

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	Introduction: Population and Conservation Genetics; application; Genetic diversity; causes of loss of genetic diversity; cause of extinction. Genetic diversity: importance, estimation and influencing factors;	- Lectures followed by discussion - Participatory question-answer	Full Marks:100
CO2	Population Genetic theories and principles: Gene and genotype frequencies; Causes of changes in gene and genotype frequencies; Hardy-Weinberg Equilibrium; Deviation of Hardy-Weinberg Equilibrium; Application.	- Lectures followed by discussion - Participatory question-answer - Online resources	
CO3	Genetic drift: Finite population size and genetic drift; effect of genetic drift, effective	- Lectures followed by discussion - Participatory question-answer	

	population size, separating sexes, variations in number gametes, inbreeding, variation in time, age; structure, neighbourhood size	- Online resources	
CO4	Inbreeding: types, methods of estimation and consequences.	- Lectures followed by discussion - Participatory question-answer	
CO5	Population connectivity and structure: Dispersal; Gene flow; Limitation of freshwater aquatic organisms; genetic structure of random mating populations; Genetics of population structure and fragmentation; Coefficient of genetic differentiation – F_{ST}, R_{ST}, Q_{ST}, G_{ST} - their relative merits & demerits; Genetic similarity & distance.	- Lectures followed by discussion - Participatory question-answer - Online resources - Video demonstration	
CO6	Genome mapping and DNA fingerprinting: Cytogenetics and physical mapping; DNA based technology; Linkage mapping; Multilocus DNA fingerprinting, applications and genome mapping; DNA sequencing.	- Lectures followed by discussion - Participatory question-answer - Online resources	
CO7	Taxonomic, biochemical and molecular tools in stock composition analyses: General principles and applications.	- Lectures followed by discussion	
CO8	Mitochondrial DNA: The mitochondrial genome; analysis of fish population structure.	- Lectures followed by discussion	
CO9	Threatened species: Threatened species as per guidelines of IUCN. Genetic aspects of endangered population.	- Lectures followed by discussion	
CO10	Fish Genetic diversity of Bangladesh: Endemic species; Exotic species; Causes of loss of genetic diversity; Genetic evaluation of exotics and quarantine procedures.	- Lectures followed by discussion - Participatory question-answer	
CO11	Conservation and preservation of aquatic species:issues and strategies, In-situ and Ex-situ conservations; Institutes and Societies associated with conservation.	- Lectures followed by discussion - Participatory question-answer	

Recommended books/literature:

1. R. Frankham, J. D. Ballou and D. A. Briscoe. Introduction to Conservation Genetics. Cambridge University Press.
2. Allendorf and G. H. Luikart. Conservation and the Genetics of Population. F. W. Blackwell Publishing.
3. M. B. Hamilton. Population Genetics. Blackwell-Willey.
4. Ryman, N. and Utter, F (editors) 1987. Population Genetics and Fishery Management. Washington Sea Grant Program, University of Washington Press, Seattle and London.
5. Falconer, D.S. and Mackay, T.F.C., 1996. Introduction to Quantitative Genetics (4rd Edition) Longman, UK. 5
6. Chapman, B. (Editor), 1985. General and Quantitative Genetics. Elsevier Science Publishers, B.V. Amsterdam-Oxford-New York-Tokyo.
7. Hartl, D.L. and Clark, A.G., 1989. Principles of Population Genetics (2nd edition). Sinauer Associates, Sunderland, MA
8. Hedrick, P.W., 1985. Genetics of Populations. Jones and Bartlett Publishers, Inc. Boston.
9. Kirby, L.T., 1990. DNA Fingerprinting: An Introduction. W.H. Freeman and Co. Saltlake City, UT. 5. Mayden, R.L. (Editor), 1993.
10. Mustafa, G. 1999. Genetics in Sustainable Fisheries Management. Blackwell Science Ltd.

11. Soule, M.E. (Editor), 1987. Viable Populations for Conservation. Cambridge University Press.
12. Turner, B.J. (Editor), 1984. Evolutionary Genetics of Fishes. Plenum Press.
13. Whitemore D.H. (Editor) 1990. Electrophoretic and Isoelectric Focussing Techniques in Fisheries Management. CRC Press.
14. Gupta PK (1998) Cytology Genetics and Molecular Biology. Rastagi Publications, India.
15. Shah MS (2010) Genetics of Aquaculture and Fisheries Management, first edition. Published by MrsZinnatunAra Shah, Khulna, Bangladesh.
16. Tave D (1993) Genetics for Fish Hatchery Manager, second edition. AVI Book. New York, USA.

MPO-808: Advanced Freshwater Aquaculture
Full Marks: 100; Credit: 2

Course Description
The course deals with different types of culture types such as monoculture, polyculture, integrated aquaculture and low-cost aquaculture. The course is designed to estimate and suggest feed requirement, and feeding strategy in different aquaculture systems. Additionally, it focuses on solutions and suggestions to the problems of on-going freshwater aquaculture operations.

Course Objectives:
To provide students with the advance knowledge of practices, problems and solutions in freshwater aquaculture.

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

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

COs	Course Outcomes	Lectures
CO1	Describe the present culture practices all over the country.	2
CO2	Demonstrate and suggest about Monoculture, polyculture, integrated aquaculture, low-cost aquaculture	3
CO3	Estimate feed requirement, and feeding strategy in different aquaculture systems.	3
CO4	Manage freshwater aquaculture farm.	3
CO5	Demonstrate and suggest about culture of commercially available fish species.	3
CO6	Demonstrate and suggest culture of commercially available fish and shellfishes.	4
CO7	Operate artificial breeding program in hatchery.	3

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	Present status of culture practices, importance, their problem, solutions and future prospects of aquaculture.	-Lectures followed by discussion -Participatory question-answer	Full Marks: 100
CO2	Culture techniques, their advancement, problems and solutions of monoculture, polyculture, integrated aquaculture, low-cost aquaculture and sustainable aquaculture.	-Lectures followed by discussion -Participatory question-answer	
CO3	Feed and nutritional requirement in different types of culture system and culture species, feed ingredients, feed formulation, and feed regime	-Lectures followed by discussion -Participatory question-answer	

CO4	Management practices for freshwater aquaculture (pre-stocking, stocking, and post- stocking management.	-Lectures followed by discussion -Participatory question-answer	
CO5	Culture of carps, catfishes, tilapias, thaipunti, pangas.	-Lectures followed by discussion -Participatory question-answer	
CO6	Culture of shrimp, prawns, cuchia and crabs.	-Lectures followed by discussion	
CO7	Hatchery management: Induced breeding techniques, inbreeding problem in aquaculture and techniques of broodstock management.	-Lectures followed by discussion -Participatory question-answer	

Recommended books/literature:

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

MPO-809: Advanced Coastal and Marine Aquaculture
Full Marks: 100; Credit: 2

Course Description:

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

Course Objectives:

To provide students with the advanced practices of coastal aquaculture, aquaculture systems and culture of finfish, shellfish in coastal and marine area, mangrove fisheries and induced practices of pearl culture.

Learning Outcomes:

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

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

COs	Course Outcomes	Lectures
CO1	Discuss about coast, coastal and marine areas, coastal boundaries, present status and problems of coastal aquaculture and mariculture in Bangladesh.	2
CO2	Identify the coastal aquaculture practices in Open, semi closed, closed, polder culture and new approaches.	3
CO3	Select the site of culture areas, design and construction of culture facilities in shore areas; various farming techniques (intertidal, sub-tidal, pens, floating cages, etc.); breeding and larval rearing of marine fin fishes, prawns and other marine organisms.	3

CO4	Learn and practice 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.	4
CO5	Discuss about mangrove ecosystem; energy flow in mangrove swamp; impact of deforestation; prospects of fisheries and fish culture in mangrove areas.	3
CO6	Know about various pearl bearing oysters, life cycle of pearl oyster and techniques of pearl culture	4
CO7	Different systems of Cage culture and rope culture.	2

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	Introduction: Present status, problems and prospects of coastal aquaculture and mariculture in Banglades	-Lectures followed by discussion -Participatory question-answer	Full Marks: 100
CO2	Coastal aquaculture practices: Open, semi closed, closed, polder culture and new approaches.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO3	Site selection, design and construction of culture facilities in shore areas; various farming techniques breeding and larval rearing of marine fin fishes, prawns and other marine organisms.	-Lectures followed by discussion -Participatory question-answer	
CO4	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.	-Lectures followed by discussion -Participatory question-answer	
CO5	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	
CO6	Pearl culture: Life cycle of pearl oyster, techniques of pearl culture	-Lectures followed by discussion -Power Point presentation and --	
CO7	Mariculture techniques: Cage culture, rope culture etc.	-Lectures followed by discussion -PowerPoint presentation	

Recommended books/literature:

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

MPO-810: Advanced Fish Nutrition
Full Marks: 100; Credit: 2

Course Description:
The course describes dietary protein and amino acid requirement of culturable fish and shell fish. The course covers larval and brood stock nutritional requirement and formulate feed for brood and larval fish. Further, it focuses on digestion of feed and factors affecting digestibility for maximum utilization of feed. The course is designed to provide a broad knowledge about nutritional disorder in fish.

Course Objectives:
To provide the knowledge of nutrition requirement of cultured fish, broodstock, crustacean and mollusk.

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

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

COs	Course Outcomes	Lectures
CO1	Describe Nutritional terminology and role of nutrition in fisheries and aquaculture;	1
CO2	Demonstrate and formulate nutritional value of protein, optimum dietary protein level, Dietary Protein and amino acid requirement of fish and shell fish.	3
CO3	Describe and demonstrate application of sources of nutrition: naturally produced food in ponds; food produced through fertilization and supplementary feeding and complete artificial feeding.	3
CO4	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.	3
CO5	Analyze digestibility in fish, determination of digestibility, Markers, Factors influencing digestibility.	3
CO6	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.	3
CO7	Explain Broodstock nutrition: energy partitioning for reproduction, protein requirement of broodstock, effect of dietary quality on reproductive output, known nutritional requirements of some broodstock fishes. Formulate feed for broodstock.	2
CO8	Identify nutritional disorders, solve the problem and suggest thereby.	2

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	Introduction, rationale, and expected outcome.	-Lectures followed by discussion -Participatory question-answer	Full Marks: 100
CO2	Definition of fish nutrition; nutritional requirements of culturable fishes and shellfishes; proteins and amino acids; lipids and fatty acids; carbohydrates, vitamins, minerals, and water.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO3	Sources of nutrition: naturally produced food in ponds; food produced through	-Lectures followed by discussion -Participatory question-answer	

	fertilization and supplementary feeding and complete artificial feeding.	-Online resources	
CO4	Digestion and absorption of feed: General anatomy and organ physiology, digestive fluids and enzymes, protein, fat, carbohydrate and microbial digestion, rate of digestion, factors affecting the rate of digestion, absorption.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO5	Digestibility study of fish feed: Digestion co-efficient, determination of nutrient digestibility, apparent and true digestibility, factors affection digestibility.	-Lectures followed by discussion -Participatory question-answer -Online resources -Video demonstration	
CO6	Energy metabolism in cultivated fishes and crustaceans: units of measurement and definition of terms, partitioning of biological energy, energy flow in the animal system, specific dynamic action, energy metabolism in fish, the energy requirement of fish, factors affecting energy requirement of fish, dietary energy sources.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO7	Broodstock nutrition: energy partitioning for reproduction, protein requirement of broodstock, the effect of dietary quality on reproductive output, known nutritional requirements of some broodstock fishes.	-Lectures followed by discussion -Participatory question-answer	
CO8	Nutritional disorders: disorders in protein nutrition, disorders in lipid nutrition, disorders in mineral deficiency, disorders in vitamin nutrition	-Lectures followed by discussion -Participatory question-answer	

Recommended books/literature:

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

MPO-811: Fish Disease and Health Management
Full Marks: 100; Credit: 2

Course Description:

The course covers the understanding of major disease, 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.

Course Objectives:

To develop knowledge of fish health and health problems, identification and improvement of fish health problems.

Learning Outcomes:

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

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

COs	Course Outcomes	Lectures
CO1	Define health and health management; know the objectives and the basic concept of fish health management.	1
CO2	Understand the sanitation practices for fish ponds and tanks, recirculation systems; water, diets, animals, hands, feet and equipment, new species, eggs, design facility.	2
CO3	Know the effective principles of prophylaxis of fish disease.	2
CO4	Describe the importance of history and records; understand the submission techniques of water and fish sample to the diagnostic laboratory.	2
CO5	Know the principles and techniques of disease diagnosis.	3
CO6	Describe the types of therapy and the therapeutic treatments.	2
CO7	Know the methods of vaccination, factors determine how well a vaccine will work, the requirement for developing a vaccine.	3
CO8	Explain the prevention and control ways of infections and non-infectious fish diseases.	3
CO9	Know the effects of intensification on shrimp health; understand the relationship between health and environment; describe the health hazards and their management.	3

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	**Introduction:** Definition and objectives of fish health management; the basic concept of fish health management.	-Lectures followed by discussion -Online resources	Full Marks: 100
CO2	**Sanitation practices for aquaculture facilities:**Sanitation practices for fish ponds and tanks, recirculation systems; water, diets, animals, hands, feet and equipment, new species, eggs, design facility.	-Lectures followed by discussion -Online resources -Slide show	
CO3	**Prophylaxis of fish disease:** Effective principles of prophylaxis of fish disease.	-Lectures followed by discussion -Online resources	
CO4	**Submission of fish for diagnostic evaluation:** Importance of history and records, submission techniques of water and fish sample to the diagnostic laboratory, the value of the sample.	-Lectures followed by discussion -Online resources -Slid show	
CO5	**Diagnosis of fish disease:** Principles of disease diagnosis, epidemiological and clinical diagnosis, postmortem examination, microbiological, histopathological and haematological methods.	-Lectures followed by discussion -Online resources -Slide show	
CO6	**Therapy of fish disease:** Definition and types of therapy, chemotherapy, chemotheraputic treatment.	-Lectures followed by discussion -Online resources Slide show	
CO7	**Vaccination in aquaculture:** Definition and methods of vaccination, vaccines for fish, factors determine how well a vaccine will work, the requirement for developing a vaccine, vaccines and disease control.	-Lectures followed by discussion -Online resources	

CO8	**Prevention and control of diseases:** Common infections and noninfectious diseases in fish.	-Lectures followed by discussion -Online resources	
CO9	**Shrimp health maintenance:** Effects of intensification on shrimp health, the relationship between health and environment; health hazards and their management.	-Lectures followed by discussion -Online resources -Slide show	

Recommended books/literature:

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

MPO-812: Fish Farming Systems
Full Marks: 100; Credit: 2

Course Description:

The course describesdeterminants and components of farming system; and integration between components. The course comprises problem and prospects of entrepreneurship in aquaculture. This course will help students to be spirited as an entrepreneur in aquaculture sector.

Course Objectives:

To develop advanced knowledge of fish farming system and farming system research for long term planning of aquaculture development.

Learning Outcomes:

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

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

COs	Course Outcomes	Lectures
CO1	Describe about rationale and outcome of learning fish farming system.	1
CO2	Define fish farming systems, farming system research and farming system development. Describe the characteristics, aim, importance and classification of farming system.	3
CO3	Describe about different determinants and components of farming system; and integration between components.	3
CO4	Explain development and limitations of development in Bangladesh.	3
CO5	Describe different tools of farming system research and apply in aquaculture research field.	3
CO6	Differentiate between entrepreneur and promotor, describe the character, quality and barrier of an entrepreneur.	3
CO7	Know the limit of loan, and terms and conditions for granting loan for different culture system of different bank and NGO's; and will be prepare as an entrepreneur.	3

CO8	Know the trend of aquaculture development in Bangladesh and formulate future plan to fulfill the need of increased population.	3

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	Rationale, importance and expected outcomes of learning fish farming system and farming system research in Bangladesh.	-Lectures followed by discussion -Participatory question-answer	Full Marks: 100
CO2	Fish farming systems, farming system research and farming system development: characteristics, aim, importance and classification	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO3	Determinants and components of farming system; and integration between components.	-Lectures followed by discussion -Participatory question-answer	
CO4	Development and limitations of aquaculture in Bangladesh.	-Lectures followed by discussion -Participatory question-answer	
CO5	Tools of farming system research and their application in aquaculture research field.	-Lectures followed by discussion -Participatory question-answer	
CO6	Entrepreneur: characteristics, risk, quality and barrier. Entrepreneurship in aquaculture.	-Lectures followed by discussion -Participatory question-answer	
CO7	Bank loan in aquaculture sector: the limit of loan, terms and conditions for granting loan for different culture system of different bank and NGO's.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO8	Trend of aquaculture development in Bangladesh, Future plan to fulfill the need of increased population	-Lectures followed by discussion -Participatory question-answer -Online resources	

Recommended books/literature:

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

MPO-813: Advanced Livelihood in Fisheries
Full Marks: 100; Credit: 2

Course Description:

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

Course Objectives:

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

Learning Outcomes:

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

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

COs	Course Outcomes	Lectures
CO1	Explain the introductory aspects, rationale, and expected outcome.	1
CO2	Describe the concept of livelihood.	1
CO3	Explain the SLA framework.	2
CO4	Describe about livelihood security and vulnerability.	2
CO5	Describe the livelihood analysis, case study.	2
CO6	Explain about the livelihood assets of the fishermen households.	4
CO7	Describe about the char fisheries livelihood.	2
CO8	Describe about the floodplain and coastal fisheries in livelihood development.	4
CO9	Explain the sustainable livelihood approaches and government perspective.	2
CO10	Explain about livelihood strategies, process, and outcomes.	1

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	Introduction, rationale, and expected outcome.	-Lectures followed by discussion	Full Marks: 100
CO2	Concept of livelihood.	-Lectures followed by discussion	
CO3	SLA framework.	-Lectures followed by discussion	
CO4	Livelihood security and vulnerability.	-Lectures followed by discussion	
CO5	Livelihood analysis, case study.	-Lectures followed by discussion	
CO6	Livelihood assets of the fishermen households.	-Lectures followed by discussion	
CO7	Char fisheries livelihood.	-Lectures followed by discussion	
CO8	Floodplain and coastal fisheries in livelihood development.	-Lectures followed by discussion	
CO9	Sustainable livelihood approaches and government perspective.	-Lectures followed by discussion	
CO10	Livelihood strategies, process, and outcomes.	-Lectures followed by discussion	

Recommended books/literature:

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

MPO-814: Fisheries Resources
Full Marks: 100; Credit: 2

Course Description:
This course deals with advance concept of the fish, fishery, fisheries resources and classification of major fish orders with special reference to freshwater fishes of Bangladesh. This course will 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 inBangladesh and their mandate and legal frame work and to interpret fisheries production statistics for promoting aquaculture resources in Bangladesh.

Course Objectives:
To provide the knowledge of the fish, fishery, fisheries and 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-

COs	Course Outcomes	Lectures
CO1	Describe basic concept of fish, shellfish, fishery, fisheries (science and sector), capture and culture fisheries, aquaculture	2
CO2	Classify major fish orders (Clupeiformes, Cypriniformes, Siluriformes, Perciformes) with special reference to freshwater fishes of Bangladesh.	4
CO3	Describe different types and importance of fisheries resources.	1
CO4	Distinguish Freshwater, Estuary and Marine waterbodies of Bangladesh.	2
CO5	Characterize commercially important fish groups like Feather backs, Eels, Shads, Milk fishes, Snakeheads, Carps, Barbs, Minnows, Catfishes, Perches, Mullets, Gobies etc.	1
CO6	Discuss commercially important shellfish groups (Prawn and Shrimps) and other fisheries items (Crabs, Turtles, Crocodiles etc).	2
CO7	Explain exotic fishes of Bangladesh and their impact in our ecosystem.	2
CO8	Categorize threatened fishes of Bangladesh and their present status.	2
CO9	Know and identify the Small Indigenous Species (SIS) and Cultivable fish species in fresh water habitat.	3
CO10	Describe the Ornamental fishes of Bangladesh (live bearing and egg laying species) and their commercial values and income generation towards entrepreneurships.	1
CO11	Describe Fisheries institutional resource in Bangladesh and their mandate. Manpower (Scientific personnel, fishers, etc.), Cooperatives (GO, NGO etc.) and fisheries legislation (policy and legal frame work)	2
CO12	Interpret the Fisheries statistics (fish production performance, public and private sector fisheries infrastructure. consumption and export, aquaculture contribution, GDP etc.) for promoting fisheries resources	2

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	General concept of fish, shellfish, fishery, fisheries (science and sector), capture and culture fisheries, aquaculture	-Lectures followed by discussion -Participatory question-answer	Full Marks : 100
CO2	Classification of Fishes: classification of major fish orders with special reference to	-Lectures followed by discussion -Participatory question-answer	

	freshwater bodies of Bangladesh. Clupeiformes, Cypriniformes, Siluriformes, Perciformes and others.	-Online resources	
CO3	Types and importance of fisheries resources: Physical, Biological and others fisheries resource.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO4	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	
CO5	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	
CO6	Commercially important shellfish groups and other fisheries items: Prawn and Shrimps, Crabs, Turtles, Crocodiles etc.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO7	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	
CO8	Threatened fishes of Bangladesh (Vulnerable, endangered, Critically endangered, extinct species) and their present status.	-Lectures followed by discussion -Participatory question-answer	
CO9	Small Indigenous Species (SIS), Cultivable fish species in fresh water habitat.	-Lectures followed by discussion -Participatory question-answer	
CO10	Ornamental fishes of Bangladesh with emphasis on live bearing and egg laying species	-Lectures followed by discussion -Participatory question-answer	
CO11	Fisheries institutional resource in Bangladesh and mandate. Manpower (Scientific personnel, fishersetc.), Cooperatives (GO, NGO etc.) and fisheries legislation (policy and legal frame work)	-Lectures followed by discussion -Participatory question-answer	
CO12	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 books/ literature:

1. The Fishes of India. F. Day, 1971. Today and Tomorrow Book Agency, New Delhi.
2. Freshwater Fishes of Bangladesh (2nd ed.). A. K. Ataur Rahman (2005). Zool. Soc. Bangladesh, Dhaka.
3. Fishes of the World. J. S. Nelson, 2006. John Wiley and Sons. New York, Toronto, Sydney.
4. Inland Fishes of India and Adjacent Countries. Vols. 1 and 2, P. K. Talwar and A. G. Jhingran (1991). Oxford and IBH Publ. Co. Calcutta, India.
5. Prawns and Prawn Fisheries of India. C. V. Kurian and V. O. Sebastian. (1982). Hindustan Publishing Corporation (India), Delhi-110007.

MPO-815: Aquatic Environment and Pollution
Full Marks: 100; Credit: 2

Course Description:
The course covers the understanding of potentialities of different aquatic environments and the degradation pathways of aquatic environment. The course designed to develop knowledge of aquatic environmental principles, regulatory/limiting factors and environmental alteration. This course can also teach the mechanisms of aquatic environmental pollution from different sources. This course will also be focused on aquatic environmental legislations authority and amelioration process of aquatic environmental pollution.

Course Objectives:
To provide students with the knowledge of various aspects of aquatic pollution and control measure as well.

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

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

COs	Course Outcomes	Lectures
CO 1	Describe about rationale and expected outcome of the course.	1
CO 2	Explain and demonstrate about potentials and importance of aquatic environment in fish farming.	1
CO 3	Explain about the principles of aquaculture ecosystem.	2
CO 4	Learn about physical factors of aquatic environment like light, temperature, pressure and depth of aquatic environment; and how these factors can affect fish production in pond fish farming; and apply this knowledge in pond management.	2
CO 5	Learn about chemical factors of aquatic environment like pH, DO, CO_2, alkalinity, hardness and ammonia-nitrogen; and how these factors can affect fish production in pond fish farming; and apply this knowledge in pond management.	2
CO 6	Learn about biological factors of aquatic environment like plankton community, stocking density, stocking ratio and predation and how these factors can affect fish production in pond fish farming; and apply these knowledges in pond management.	2
CO 7	Learn about different aquaculture related activities and how these activities can affect our environment and apply this knowledge in mitigating environmental problems due to such activities.	2
CO 8	Explain about the source and causes of aquatic pollution; and apply these learning in preventing pollution in fish pond.	2
CO 9	Differentiate between water pollution and water scarcity. Categorize and explain the causes of water pollution and water scarcity.	2
CO 10	Describe the causes of industrial pollution, explain present status of industrial pollution in Bangladesh, know the impact of such kind of pollution on fisheries resources; and apply these learnings in preventing industrial pollution in aquatic environment.	2
CO 11	Describe the source and causes of agrochemical pollution, explain the impact of such kind of pollution on fisheries resources; and apply these learnings in preventing agrochemical pollution in aquatic environment.	2
CO 12	Define algal bloom and algal toxin, describe the types and impact of harmful algal bloom in fish pond; and apply these learnings for better production by controlling algal bloom.	2

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	Present status, importance and expected outcomes of pollution on aquatic environment	-Lectures followed by discussion -Participatory question-answer	Full Marks: 100
CO2	Introduction of aquatic environment: Concept, types, and potentials of the aquatic environment, the importance of aquatic environment maintenance	-Lectures followed by discussion -Participatory question-answer	
CO3	Environmental principles: Principles and their application to the management of the aquatic ecosystem	-Lectures followed by discussion -Participatory question-answer	
CO4	Physical factors of aquatic environment (light, temperature, pressure and depth): importance, effect, fluctuations and control measures.	-Lectures followed by discussion -Participatory question-answer	
CO5	Chemical factors of aquatic environment (DO, CO_2, alkalinity, hardness, pH, ammonia, nitrogen-nitrite etc.): importance, effect, fluctuations and control measures.	-Lectures followed by discussion -Participatory question-answer	
CO6	Biological factors of aquatic environment (phytoplankton, stocking density, grazing etc.): importance, effect, fluctuations and control measures.	-Lectures followed by discussion -Participatory question-answer	
CO7	Impacts of aquaculture on the aquatic environment, mitigation measures	-Lectures followed by discussion -Participatory question-answer	
CO8	Environmental degradation: Definition, causes, and impacts on fisheries.	-Lectures followed by discussion -Participatory question-answer	
CO9	Water pollution and water scarcity: Categories and causes of water pollution and water scarcity, state and impact of water pollution and scarcity, human response, gaps and future concerns, actions for water pollution management.	-Lectures followed by discussion -Participatory question-answer	
CO10	Industrial pollution: Causes of industrial pollution, the present state of industrial pollution in Bangladesh, impacts on fisheries resources and control	-Lectures followed by discussion -Participatory question-answer	
CO11	Agrochemicals pollution: Agrochemicals concern water pollution, ways of pollution and impacts.	-Lectures followed by discussion -Participatory question-answer	
CO12	Algal pollution: Causes of algal bloom, definition, and types of harmful algal bloom, algal toxins, impacts of algal pollution on fisheries	-Lectures followed by discussion -Participatory question-answer	

Recommended books/literature:

1. Lloyd, R. 1992. Pollution and Freshwater Fish. Fishing News Books, Oxford, 176.
2. Moriarty, F. 1993. Ecotoxicology: The Study of Pollutants in Ecosystems. Second Edition. T. J. Press (Padstow) Ltd., Padstow, Cornwall, Great Britain. 289 pp.
3. Calhoun, Y. 2005. Water Pollution. Chelsea House Publishers. 164 pp.

4. Carmichael, W. W. 1981. The Water Environment: Algal Toxins and Health. Plenum Press. New York. 491 pp.
5. Boyd, C. E. 1988. Water Quality Management for Pond Fish Culture. Elsevier Scientific Publisher B. V., Amsterdam. 318 pp.
6. Calow, P. 1993 (ed.) Handbook of Ecotoxicology. Volume One. T.J. Press (Padstow) Ltd., Padstow, Cornwall, Great Britain. 289 pp.
7. Falconer, I. R. 1993. Algal Toxins in Sea Food and Drinking Water. Academic Press. 224 pp.

MPO-816: Inland Fisheries Management
Full Marks: 100; Credit: 2

Course Description:
The course coverers fisheries resources and its management, sectoral policies and programmes on fisheries, current five-year development activities of the Ministry of Fisheries, present status of fish seed production from natural and artificial sources, relations of flood and monsoon to inland and marine capture fisheries of Bangladesh, agro-ecological zoning system, recreational use of water resources and fisheries resource survey system (FRSS) of Bangladesh. The course is designed to strengthen the student's existing knowledge on Inland fisheries resources management and conservation.

Course Objectives:
To provide the students with knowledge on fisheries resources, with its conservation and management measures.

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 this course, the students will be able to-

COs	Course Outcomes	Lectures
CO1	Describe rationale, and expected outcome.	2
CO2	Describe waterbodies (ponds and lakes, rivers, canals, floodplains, beels, haors, baors, estuaries, and Bay of Bengal) and their origin and morphology.	3
CO3	Describes the biodiversity of fishes, introduced fish species (exotics), non-piscine fisheries organisms, other aquatic living resources of commercial and economic importance	3
CO4	Describe Present status of water bodies, nature, and extent of utilization, potentials for future management, sectoral policies and programmes	2
CO5	Describe present status of fish seed production from natural and artificial sources, diversity of ichthyo-plankton and seeds of other non-conventional aquatic fauna in the natural habitats.	2
CO6	Describe the relations of flood and monsoon to inland capture fisheries of Bangladesh.	2
CO7	Describe Fisheries resource survey system (FRSS) of Bangladesh	2
CO8	Ecosystem approaches in fisheries Managemenr (EAFM) and small scale fisheries.	6

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	Introduction, rationale, and expected outcome.	-Lectures followed by discussion -Participatory question-answer	Full Marks: 100
CO2	Physical resources of Bangladesh: (a) Waterbodies - ponds and lakes, rivers, canals, floodplains, beels, haors, baors,	-Lectures followed by discussion -Participatory question-answer -Online resources	

	estuaries, and Bay of Bengal - their origin and morphology; (b) other physical resources- organizations, institutions, private entrepreneurs, manpower, capital, and finance (Banks, NGOs), fish seed multiplication farms and hatcheries.		
CO3	Biological resources: Biodiversity of fishes, introduced fish species (exotics), non-piscine fisheries organisms, other aquatic living resources of commercial and economic importance.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO4	Present status of water bodies, nature, and extent of utilization, potentials for future management, sectoral policies and programmes on fisheries and wetland habitats of different ministries and departments, current five-year development activities of the Ministry of Fisheries.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO5	Present status of fish seed production from natural and artificial sources, availability of shrimp seeds and crab juveniles, diversity of ichthyo-plankton and seeds of other non-conventional aquatic fauna in the natural habitats.	-Lectures followed by discussion -Participatory question-answer -Online resources -Video demonstration	
CO6	Relations of flood and monsoon to inland and marine capture fisheries of Bangladesh, changes of water bodies due to natural influences and human activities and their impacts of fish population or stocks, GIS and agro-ecological zoning system, surface water modeling, mapping of vulnerable areas for fisheries.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO7	Fisheries resource survey system (FRSS) of Bangladesh: Present status of fisheries statistics, methods used in FRSS, weakness, the scope of further development.	-Lectures followed by discussion -Participatory question-answer	
CO8	Ecosystem approaches in fisheries Management and small scale fisheries.	-Lectures followed by discussion -Participatory question-answer	

Recommended books/literature:

1) Cushing, D.H., 1977. Science and the Fisheries. Edward Arnold Publishers Ltd., Hill Street, London. 60 pp.
2) 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.
3) Gulland, J.A. (ed.), 1988. Fish Population Dynamics. Second edition. John Wiley & Sons, Inc., New York.
4) Lagler, K.F., 1956. Freshwater Biology, Second edition, William C. Brown Co. Dubuque, Iowa. 421 pp.
5) Nikolskii, G.V., 1982. Theory of fish population dynamics. Bishen Singh, Mahendra Pal Singh and Otto Koeltz, Sci. Publishers, 323 pp.
6) Parker, N.C., Albert, E.G., Roy, C.H., Douglas, Jr.J.B., Eric, D.P. and Gary, A.W., 1990. Fish Marking Techniques. Amer. Fish. Soc. Symp.-7, 876 pp.
7) Ricker, W.E., 1968. Methos of assessment of fish production in freshwaters. Blackwell Scientific Publications, Oxford, 321 pp.

MPO-817: Coastal and Marine Fisheries Management
Full Marks: 100; Credit: 2

Course Description:
The course coverers fishery survey of rivers, lakes, and ponds, managements techniques of inland water fisheries, creation of new fish habitats in inland water, existing problems in inland fisheries and their solutions, national policy and programmes for inland fisheries management, ecosystem conservation and fisheries management, national and international policies for marine fisheries management; role of government and NGOs in coastal fisheries management; property rights and coastal fisheries; role of fishers community; Bay of Bengal programme (BOBP), Socio-economic aspects , climate change and marine fisheries management. The course is designed to strengthen the student's existing knowledge on wetland ecosystem and fisheries biodiversity.

Course Objectives:
To provide the students with knowledge on inland & marine fisheries conservation and management

Learning Outcomes:
At the end of the course, the students will be able to know about different types ofinland and marine fisheries resources and its conservation and management.

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

COs	Course Outcomes	Lectures
CO1	Describe rationale, and expected outcome.	1
CO2	Know fishery survey of rivers, lakes, and ponds.	2
CO3	Know management techniques of inland water fisheries.	1
CO4	Know creation of new fish habitats in inland water.	2
CO5	Existing problems in inland fisheries and their solutions.	1
CO6	National policy and programmes for inland fisheries management.	1
CO7	Overview: Concepts of marine fisheries management; marine fisheries resources, their economic importance, and management.	2
CO8	Environment and fisheries management: Factors influencing fish life in marine water; habitat, foodand feeding habits, competition, predation, migration, spawning, pollution, and salinity; coastalweather, weather forecast; surface currents, their changes and effects on fish distribution, migrationand recruitment; diurnal behaviour of fish in relation to weather.	2
CO9	Fishing gear and fisheries management: Marine fishing gears and their impacts on fisheries resources; complexity of multigear and multispecies fisheries management; reduction of fishing effort in estuarine set bag-net (ESBN) fishery; banning of particular gear; management of industrial trawl fishery.	2
CO10	Ecosystem conservation and fisheries management: Conservation of biodiversity in fisheries management; minimizing bycatch of sensitive species groups; unreported fishing; ecosystem modeling and fisheries management; conservation rules and regulations; institutional strengthening and infrastructural development.	2
CO11	Policies and Programmes: National and international policies for marine fisheries management, role of government and NGOs in coastal fisheries management; property rights and coastal fisheries, role of fishers community, Bay of Bengal programme (BOBP).	2
CO12	Socio-economic aspects: Existing problems in marine fisheries and their solutions; fishing rights and conflicts; socioeconomic conditions of fisherfolk and their role in marine fisheries management.	2
CO13	Climate change and marine fisheries management: Impacts of climate change on coastal and marine fisheries resources; fisheries management and conservation strategies in changing climate	2

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	Describe rationale, and expected outcome.	-Lectures followed by discussion -Participatory question-answer	
CO2	Fishery survey of rivers, lakes, and ponds.	-Lectures followed by discussion -Participatory question-answer	
CO3	Management techniques of inland water fisheries.	-Lectures followed by discussion -Participatory question-answer	
CO4	Creation of new fish habitats in inland water.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO5	Existing problems in inland fisheries and their solutions.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO6	National policy and programmes for inland fisheries management.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO7	Overview: Concepts of marine fisheries management; marine fisheries resources, their economic importance, and management.	-Lectures followed by discussion -Participatory question-answer	
CO8	Environment and fisheries management: Factors influencing fish life inmarine water; habitat, food and feeding habits, competition, predation,migration, spawning, pollution, and salinity; coastal weather, weatherforecast; surface currents, their changes and effects on fish distribution,migration and recruitment; diurnal behaviour of fish in relation toweather.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO9	Fishing gear and fisheries management: Marine fishing gears and their impacts on fisheries resources; complexity of multigear and multispecies fisheries management; reduction of fishing effort in estuarine set bag-net (ESBN) fishery; banning of particular gear; management of industrial trawl fishery.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO10	Ecosystem conservation and fisheries management: Conservation of biodiversity in fisheries management; minimizing bycatch of sensitive species groups; unreported fishing; ecosystem modeling and fisheries management; conservation rules and regulations; institutional strengthening and infrastructural development.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO11	Policies and Programmes: National and international policies for marine fisheries management, role of government and NGOs in coastal fisheries management; property rights and coastal fisheries, role of fishers community, Bay of Bengal programme (BOBP).	Lectures followed by discussion Participatory question-answer Online resources Video demonstration	

CO12	Socio-economic aspects: Existing problems in marine fisheries and their solutions; fishing rights and conflicts; socioeconomic conditions of fisherfolk and their role in marine fisheries management.	Lectures followed by discussion Participatory question-answer Online resources	
CO13	Climate change and marine fisheries management: Impacts of climate change on coastal and marine fisheries resources; fisheries management and conservation strategies in changing climate	Lectures followed by discussion Participatory question-answer	

Recommended books/literature:

1. BOBP. 1993. Studies of Interactive Marine Fisheries of Bangladesh. BOBP/WP/89. Bay of Bengal Programme, Madras, India.
2. Levinton, J.S. 2008. Marine Biology: Function, Biodiversity, Ecology. Oxford University Press, USA. 640 pp.
3. Gunderson, D.R. 1993. Surveys of Fisheries Resources. John Wiley and Sons, Inc., New York. 233 pp.
4. Laevastu, T. 1993. Marine Climate, Weather and Fisheries. Blackwell Scientific Publications, Inc., England. 204 pp.
5. Glantz, M.H. (ed.). 2005. Climate Variability, Climate Change, and Fisheries. Cambridge University Press. 460 pp.
6. Parsons, T.R., Takahashi and B. Hargrave. 1984. Biological Oceanographic Process. Pergamon Press, England. 330 pp.
7. King, M., 1995. Fisheries Biology, Assessment and Management. Fishing News Books, 342 p.

MPO-818: Advanced Fish Population Dynamics
Full Marks: 100; Credit: 2

Course Description:

The course is designed to strengthen the student's existing knowledge of population's distribution and abundance and related influencing factors, relationships between different linear dimensions, best condition factor and gear selections. This course is also designed for understanding the methods for determination of ageand growth, growth performance index, longevity or life-span of fishes, size at sexual maturity, spawning- and peak-spawning season, recruitment pattern and mortality. Additionally, this course covers basic understanding the estimation of fish production methods, marking and tagging techniques, migration and life history patterns of fishes for fisheries management.

Course Objectives:

To provide knowledge to the students on population parameters, size relationship and condition factors.

Learning Outcomes:

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

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

COs	Course Outcomes	Lectures
CO1	Define the population of fish and its scope and application in fisheries science and also to know its related terminologies.	2
CO2	Estimate the Distribution and abundance and to know it's affecting factors.	2
CO3	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.	2

CO4	Estimate the growth parameters through different models (e.g., von Bertalanffy growth curve) using data from length-frequency analysis, hard part analysis, mark-recapture experiment, and graphical & computer-based analyses	2
CO5	Describe the timing of reproduction, length & age at sexual maturity, frequency of spawning, and fecundity and its application in fisheries management.	2
CO6	Know the timing of recruitment, length & age at recruitment, factors affecting recruitment and stock-recruitment relationships.	2
CO7	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.	3
CO8	Know the definition & types of migration, causes of migration, migratory circuit of fishes, migration of some important commercially important fishes (Hilsha, hering, cod etc.).	2
CO9	Describe the types, materials and duration of tags and marks, principles and techniques of tagging and marking and its application of fisheries research.	2
C10	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.	2

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	Introduction: Definition of different terminologies, salient features of population.	-Lectures followed by discussion Participatory question-answer	Full Marks :100
CO2	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 -Online resources	
CO3	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.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO4	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	
CO5	Reproduction: Definition, timing of reproduction, length & age at sexual maturity, frequency of spawning, semelparity&iteroparity, fecundity.	-Lectures followed by discussion -Participatory question-answer -Online resources -Video demonstration	
CO6	Recruitment: Definition, timing of recruitment, length & age at recruitment, factors affecting recruitment and stock-recruitment relationships	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO7	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	
CO8	Migration: Definition, Causes of migration, types of migration, migratory circuit of fishes, migration of some important commercially important fishes (Hilsha, herring, cod etc.).	-Lectures followed by discussion -Participatory question-answer	

CO9	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	
CO10	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 books/literature:

1. Dwiponggo, A., 1986. Growth, mortality and recruitment of commercially important fishes and penaeid shrimps in Indonesian waters. Filipiniana Specialist, Manila. 91 pp. FAO. 2001. Yearbook of fishery. Statistics of catches and landings.
2. 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.
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. Cushing, D.H., 1968. Fisheries Biology: A study in population dynamics. Univ. Wisconsin, Madison, USA. 200 pp.
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. Sparre, P., Ursin, E. and Venema, S.C., 1989. Introduction to tropical fish stock assessment. Part 2. Exercises. FAO Fisheries Technical Paper. No. 306.2. Rome, FAO. 429 p.

MPO-819: Fisheries Impact Assessment
Full Marks: 100; Credit: 2

Course Description:

This course describes the major sources of fisheries impacts and their effects on the environment. The course will deal in depth with the impact of intensive aquaculture on wild fish populations, including the transfer of disease and parasites; and the impact of escaped exotic fish.

Course Objectives:

To provide students with the knowledge of fisheries impacts and their effects on the environment.

Learning Outcomes:

At the end of the course, the students will be able to i) understand the how fisheries activity affects the environment;ii) How to deploy the environmental legislation (national and international), declaration of Earth Summit, environmental quality standards, and testing methods, monitoring methods, strategy of waste management.

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

COs	Course Outcomes	Lectures
CO1	Explain the rationale and expected outcome of fisheries impact assessment.	2
CO2	Illustrate the key concept of water quality.	3
CO3	Stated the water quality problems.	3
CO4	Enumerate the environmental and fisheries resources degradation.	3

CO5	Describe the impacts of freshwater aquaculture.	3
CO6	Discuss the environmental impact on coastal shrimp farming.	3
CO7	Stated the environmental issues and marine fisheries.	3
CO8	Describe the environmental legislation (national and international), environmental quality standards testing methods, monitoring methods, strategy of waste management.	4

Lesson Plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	Introduction: Rationale and expected outcome.	- Lectures followed by discussion - Online resources	Full Marks: 100
CO2	Key concept of water quality: Goals of water quality management; link among water quality, implications of differences in sensitivity to environmental change among different fish species and aquatic organisms.	- Lectures followed by discussion - Online resources	
CO3	Water quality problems: Requirements for maintenance of fish health, problems associated with oxygen regime; pH fluctuation; ammonical and nitrite nitrogen; eutrophication; heavy metals; turbidity and sedimentation; evaporation and salinization.	- Lectures followed by discussion - Online resources	
CO4	Environmental and fisheries resources degradation: Water development projects, impact of water abstraction and irrigation, barrages, roads, highways and embankments, siltation, impacts of inland capture fisheries and strategies for improvement.	- Lectures followed by discussion - Online resources	
CO5	Impacts of freshwater aquaculture: Culture practices; inputs use (feed, fertilizers, chemicals), reduction in biodiversity and use of exotics species, water quality deterioration and public health, nutrient accumulation and eutrophication, drainage effect on the adjacent areas and waterbodies.	- Lectures followed by discussion - Online resources	
CO6	Impact on coastal shrimp farming: Loss of mangrove forests, agricultural lands, livestock pastures, depletion of groundwater, salinity intrusion, eutrophication; problems associated with shrimp and other fish processing industries and their measures.	- Lectures followed by discussion - Online resources	
CO7	Environmental issues and marine fisheries: Causes of degradation of marine environment of the Bay of Bengal; oil spillage, industrial waste, ship breaking activities, municipal wastes, disposal of solid wastes; impact of marine fisheries.	- Lectures followed by discussion - Online resources	
CO8	Environmental management: Environmental legislation (national and international), declaration of Earth Summit, environmental quality standards, testing methods, monitoring methods, strategy of waste management.	- Lectures followed by discussion - Online resources	

Recommended books/literature:

1. Boyd, C.E. 1998. Water Quality Management for Pond Fish Culture. Elsevier Scientific Publisher B.V., Amsterdam. 318 pp.
2. Lloyd, R. 1992. Pollution and Freshwater Fish. Fishing News Books, Oxford, UK. 176 pp.
3. Muller, R. and R. Lloyd. 1994. Sublethal and chronic effects of pollution on freshwater fish. Fishing News Books, UK. 288 pp.
4. Calow, P. 1995. A Handbook of Ecotoxicology. Vol. 1-2. Blackwell Scientific Publications. UK.
5. Forbes, V.E. and T.L. Forbes.1994. Ecotoxicology in Theory and Practice. Chapman and Hall Publishers, London, UK.
6. Haslam, S.M. 1991. River Pollution: An Ecological Perspective. CBS Publishers & Distributors (Pvt.) Ltd.
7. Nishant, A., Z. Hossain, M.K. Roy and A. Karim (eds.). 1993. Freshwater Wetlands in Bangladesh: Issues and Approaches for Management. IUCN, Gland, Switzerland. 383 pp.
8. Pullin, R.S.V., H. Rosenthal and J.L. Maclean. 1993. Environment and Aquaculture in Developing Countries. ICLARM Conference Proceedings 31. 359 pp.
9. Pillay, T.V.R. 1992. Aquaculture and Environment. Fishing News Books, UK.
10. Rand, G.M. and S.R. Petrocelli (eds.). 1985. Fundamentals of Aquatic Toxicology. Hemisphere, Washington, D.C.

MPO-820: Modern Fishing Technology
Full Marks: 100; Credit: 2

Course Description:

The course covers the modern fishing aids, traditional fishing gears & crafts and engines used in fishing. The course is designed to strengthen the student's existing knowledge on modern fishing aids used for fish location, detection and attraction. This course can also teach them about different traditional fishing gears and crafts along with design & construction of commercial fishing boat. In addition, this course also focuses on the operation and maintenance of different engines used in fishing industry.

Course Objectives:

To provide students with the knowledge of fishing gears and crafts as well as fishing techniques in all types of water bodies.

Learning Outcomes:

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

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

COs	Course Outcomes	Lectures
CO1	Describe the modern fishing aids in terms of navigation, fish location, detection and attraction	3
CO2	Design and operate the commercial fishing methods such as trawl fishing, seining, gill netting, long lining, trap fishing, and pump fishing.	4
CO3	Describe and differentiate the traditional fishing crafts and gears used in the inland and coastal waters of Bangladesh.	4
CO4	Design and describe the construction of boat in terms of materials, timber seasoning and treatment, tools for boat care; maintenance the boats against corrosion, marine fouling, and boring.	3
CO6	Explain the types of marine engines, diesel engines, engine power, engine mounting, propeller, and liftable propulsion system; operate and maintenance of marine engines.	2

Lesson Plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	Modern fishing aids: Navigation, fish location, detection, and attraction.	-Lectures followed by discussion -Participatory question-answer	Full Marks: 100
CO2	Commercial fishing methods: Design and operation of trawl fishing, seining, gill netting, long lining, trap fishing, and pump fishing.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO3	Survey of traditional fishing crafts and gears used in the inland and coastal waters of Bangladesh.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO4	Planning and design of boat: Design and construction, materials, timber seasoning and treatment, tools for boat care, and maintenance of boats, corrosion, marine fouling, boring prevention and control of fouling, echo-sounder, fish finder.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO5	Marine engine: Types of engines, diesel engines, selection of engine power, engine mounting, propeller, and liftable propulsion system. Engine protection, operation, and maintenance.	-Lectures followed by discussion -Participatory question-answer -Online resources	

Recommended books/literature:

1. Fish Catching Methods of the World (3rd ed). 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. Harvest and Post-harvest Technology of Fish. Rabindran (ed) (1985). Soc. Fish. Technol. India.
5. Commercial Fishing Methods and Introduction to Vessels and Gears. J. C. Sainsbury (1975). Fishing News (Books) Ltd. London.

MPO-821: Fish Processing and Preservation Technology
Full Marks: 100; Credit: 2

Course Description:

The course covers the principles of fish preservation, mechanism of spoilage and quality assessment, commercial handling of fish and shellfish, value addition of wet fish and preservation by chilling and freezing. The course is designed to strengthen the student's existing knowledge on fish spoilage mechanism. This course can also teach them about fish preservation by chilling and freezing method as well as the storage and transportation of preserved fishes. This course also focuses on the freshness assessment of fish and shellfish.

Course Objectives:

To provide students with the knowledge of different processing methods of fish and shellfish, their packaging and planning and design of fish processing plant along with different preservation techniques.

Learning Outcomes:

At/by the end of the course, the students will be able to-i) Know the fish processing methods including drying, smoking, salting, canning, irradiation etc. ii) Select the proper packaging for fish and fishery products iii)Make an idea to establish fish processing plantiv) Know the commercial handling process of fish and shellfish v) Explain the chilling and freezing methods, and vi) Understand the value addition and packaging of wet fish.

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

COs	Course Outcomes	Lectures
CO1	Describe the structure of fish in terms of physical proportion, chemical composition and thermal properties of constituents	4
CO2	Apply the fish drying techniques with its storage; explain the physical and biochemical changes during drying and spoilage of dried fishery products; know the effects of illegal application of pesticides in dry fish.	2
CO3	Describe and apply the principles and techniques of fish salting; explain the ripening of salted; explain the spoilage and apply the preventive measures.	2
CO4	Describe and apply the principles and techniques with storage of fish smoking; outlines the characteristics of wood smoke, and smoke flavorings; explain the changes in fish during smoking.	3
CO5	Describe and apply the principles and techniques of fish fermentation; explain the changes in constituents during fish fermentation.	2
CO6	Describe and apply the principles and techniques of irradiation of fish in terms of sources of radiation, measurement of irradiation energy, radiation dose; explain the effect of irradiation on fish & fishery products; describe the detection of irradiation in foods.	2
CO7	Describe and apply the principles and techniques of fish canning in terms of heat penetration and process evaluation and storage; examine the cans and canned products.	2
CO8	Describe and apply the principles and techniques of fish mince and surimi in terms of gelation of fish muscle; explain the changes in muscle during heat processing.	2
CO9	State principles of fish preservation; Explain technological, chemical and bacteriological problems related to fish preservation.	2
CO10	Explain the mechanism of rigor mortis in fish; explain the effect of rigor-mortis on fish preservation; describe the bacteriological and chemical basis for deteriorative changes in fish.	3
CO11	Apply good practices in onboard and onshore handling & preparation of wet fish; practice live fish transportation; apply packaging system for preserved fish.	3
CO12	Illustrate the basic principles of cold preservation; outlines the characteristics of refrigerating media; explain the mechanism of heat transfer; describe the chilling and freezing methods; design of freezing plant; prepare chilled and frozen fish products.	2
CO13	Plan and design of fish cold storage and refrigerated fishing vessels and refrigerated transport system.	3
CO14	Assess the quality by the sensory, chemical and bacteriological methods for fishery products.	2

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	Fish as raw material: Structure of fish and physical proportion, chemical composition, physical and thermal properties of constituents.	-Lectures followed by discussion -Participatory question-answer -Online resources	Full Marks: 100
CO2	Drying and dehydration: Principles and techniques; physical and biochemical changes in dried fishery products; quality and spoilage of dried fish; illegal application of pesticides in dry fish and their lethal and sub-lethal effects; use of salt in dry fish. Packaging and storage.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO3	Salting and marinating of fish: Principles and techniques, the ripening of salted and marinated products, spoilage and their prevention.	-Lectures followed by discussion -Participatory question-answer -Online resources	

CO4	Smoking: Principles and techniques, characteristics of wood smoke, smoke flavorings; changes in fish during smoking. Shelf-life and storage of smoke fish.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO5	Fermentation: Principles and techniques, semi-fermentation and complete fermentation; changes in constituents during fish fermentation.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO6	Irradiation:Principles and techniques, sources of radiation, radiation process, measurement of irradiation energy, radiation dose, the effect of irradiation on fish & fishery products, and detection of irradiation in foods.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO7	Canning: Principles and techniques, heat penetration and process evaluation, the examination of cans and canned products. Storage of canned fish.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO8	Fish mince and surimi: Principles and techniques, gelation of fish muscle; changes in muscle during heat processing.	Lectures followed by discussion Participatory question-answer	
CO9	General principles of fish preservation. Technological, chemical and bacteriological problems related to fish preservation.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO10	Rigor-mortis: Mechanisms of rigor-mortis. Effect of rigor-mortis on fish preservation. Bacteriological and chemical basis for deteriorative changes in fish.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO11	Commercial handling of fresh fish: Onboard and onshore handling of wet fish; good practice in wet fish preparation; live carriage of fish, Packaging materials and methods of packaging for preserved fish. Shelf-life consideration of fresh fish.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO12	Refrigeration and freezing preservation: Basic principles of cold preservation. Characteristics of refrigerating media. Mechanism of heat transfer. Chilling and freezing of fish. Manufacture of ice and design of freezing plants. Production of chilled and frozen fillets, fish sticks, etc.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO13	Storage and distribution of chilled and frozen fishery products. Planning and design of commercial fishery cold storage and refrigerated fishing vessels, transportation of fish.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO14	Measuring the degree of freshness of fish. Importance of freshness test in fish preservation. Sensory, chemical and bacteriological methods.	-Lectures followed by discussion -Participatory question-answer -Online resources	

Recommended books/literature:

1. Hall, G. M. 1992. Fish Processing Technology. Blackie Academic & Professional, An Imprint of Chapman & Hall. London.
2. Rogenstein, Joe M. 1991. Introduction to Fish Technology. An Osprey Book, Van Nostrand Reinhold, New York.

3. Stansby, M. E. 1990. Industrial Fishery Technology. Reinhold Publ. Corp., New York.
4. Nowsad, A. K. M. A. 2005. Handling and Preparation of Wet Fish for Marketing (In Bengali). BGD/97/017 Field Doc. 2/2005 FAO, Bangladesh
5. Nowsad, A. K. M. A. 2007. Participatory Training of Trainers: A New Approach Applied in Fish Processing. Bangladesh Fisheries Research Forum. Bangladesh.
6. Mansur, M.A. 2012. Fisheries Studies: Part-II. Botomul (Publisher), Dhaka.
7. Brogstrom, G. (Ed). 1965.Fish as Food. Vols. I-IV. Academic press, London.
8. Clucas, I. J. (Editor) 1985. Fish Handling, Preservation and Processing in the Tropics. Part-I and II. 2nd edition. Tropical Development and Research Institute, London, Overseas Development Administration, U.K.
9. Govinda, T. K. 1985. Fish Processing Technology. Oxford and IBH Publishing Co., New Delhi.
10. Kreuzer, R. 1969. Technology of Fish Utilization. Fishing News (Books) Ltd., London.
11. Ravindran, K., N. Nair, I. A. Perigreen, P. A. Panicker and M. Thomas. 1985. Harvest and Post-harvest Technology of Fish. Society of Fisheries Technologists, India.
12. Tanikawa, E. 1985. Marine Products in Japan. Koseikaku Co., Ltd., Tokyo, Japan.
13. Wheaton, F. W. and T. B. Lawson. 1985. Processing of Aquatic Food Products, Wiley and Sons, New York.

MPO-822: Advanced Fisheries Microbiology and Microbial Technique
Full Marks: 100; Credit: 2

Course Description:
The course covers the microbial contamination & spoilage and food safety and the role of microorganism in fish and fishery products, and different analytical techniques for fish and fishery products. The course is designed to strengthen the student's existing knowledge on spoilage mechanism of fish and shellfish and seafood borne illness. This course can also teach them about microbial spoilage of fish mince and value added fishery products. This course also focuses the sanitation and hygiene of fish processing plant.

Course Objectives:
To provide students with the knowledge of the aquatic microorganism, role of microorganism on contamination and spoilage, effects of processing on microorganisms and food-borne illness along with different analytical techniques for fish and fishery products.

Learning Outcomes:
At/by the end of the course, the students will be able to i) know about spoilage of foods and pathogenic bacteria and decontamination of bacteria by processing methods ii) know the basic principles of different biochemical techniques iii) know the basic principles of different microbiological analysis.

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

COs	Course Outcomes	Lectures
CO1	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
CO2	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
CO3	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

CO4	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
CO5	Explain the effects of different preservation & processing methods on microorganisms such as low temperature, high temperature, curing and other methods	3
CO6	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
CO7	Explain the general principles of separation of micro and macro molecules, selection of appropriate tools for analysis of fish samples; Outlines of common techniques involved in biochemical analysis.	2
CO8	Explain the centrifugation techniques in terms of types, concept of Svedberg unit, analytical ultracentrifuge.	3
CO9	Describe and apply the quality test for fish and fishery products such as Free fatty acid value, peroxide value, iodine value, K-value, Thiobarbituric acid reactive substance (TBARS) value, non-protein nitrogen, trimethyl amine, total volatile base nitrogen, preparation of myofibril, myosin and actin, ATPase assay in fish muscle.	3
CO10	Describe the spectroscopic techniques with their principles such as UV, Visible and IR spectroscopy, spectrofluorimetry, flame photometry, atomic absorption spectrophotometry, ICP- AES, mass spectrometer.	2
CO11	Explain the electrophoretic techniques with general principles and classification such as Paper electrophoresis, Native and reduced PAGE, IEF, capillary electrophoresis, 2D Gel electrophoresis.	2
CO12	Describe the chromatographic Techniques with its general principles, types, chromatography -adsorption, partition, ion-exchange, molecular sieve, affinity; explain the gas chromatography, thin layer chromatography. Gas chromatography, High performance Liquid chromatography, LC MS-MS.	2
CO13	Design and manage a food microbiological laboratory in terms of concern, siting, and servicing of the laboratory, equipment, assessment of risk and control measures, chemical and biological safety cabinets, laboratory philosophy.	2
CO14	Explain and apply the methods for the microbiological examination of fish and fishery products in terms of sampling, enumeration, isolation, characterization, and identification of microorganisms.	2
CO15	Describe and apply the assessment method of microbiological quality of fish and fishery products such as fresh fish, frozen fish, heated canned fish products, cured fish and fermented products.	2
CO16	Describe and apply microbiology of factory hygiene and sanitation in terms of factory buildings infrastructural implications, safety and maintenance.	2

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	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	Full Marks: 100

CO2	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	
CO3	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	
CO4	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	
CO5	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	
CO6	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	
CO7	General principles of separation of micro and macro molecules, selection of appropriate tools for analysis of fish samples. Outlines of common techniques involved in biochemical analysis.	Lectures followed by discussion	
CO8	Centrifugation techniques: Types of centrifugation, concept of Svedberg unit, analytical ultracentrifuge.	Lectures followed by discussion	
CO9	Quality test for fish and fishery products: Free fatty acid value, peroxide value, iodine value, K-value, Thiobarbituric acid reactive substance (TBARS) value, non-protein nitrogen, trimethyl amine, total volatile base nitrogen, preparation of myofibril, myosin and actin, ATPase assay in fish muscle.	Lectures followed by discussion	
CO10	Spectroscopic techniques: Principles, UV, Visible and IR spectroscopy, spectrofluorimetry, flame photometry, atomic absorption spectrophotometry, ICP- AES, mass spectrometer.	Lectures followed by discussion	
CO11	Electrophoretic techniques: General principles, Classification, Paper electrophoresis, Native and reduced PAGE, IEF, capillary electrophoresis, 2D Gel electrophoresis.	Lectures followed by discussion	
CO12	Chromatographic Techniques: General principles, types of chromatography -adsorption, partition, ion-exchange, molecular sieve,	Lectures followed by discussion	

	affinity, gas chromatography, thin layer chromatography. Gas chromatography, High performance Liquid chromatography, LC MS-MS.		
CO13	Design and management of a food microbiological laboratory: Need for concern, siting, and servicing of the laboratory, equipment, assessment of risk and control measures, chemical and biological safety cabinets, laboratory philosophy.	Lectures followed by discussion	
CO14	Methods for the microbiological examination of fish and fishery products: Sampling, enumeration, isolation, characterization, and identification of microorganisms.	Lectures followed by discussion	
CO15	Assessment of microbiological quality of fish and fishery products: fresh fish, frozen fish, heated canned fish products, cured fish and fermented products.	Lectures followed by discussion	
CO16	Microbiology of factory hygiene and sanitation: Factory buildings infrastructural implications, safety and maintenance.	Participatory question-answer	

Recommended books/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. Microbiology of Marine Food Products. Ward, D. R. and C. Hackney. 1991. Van Nostrand Reinhold, New York. 438 pp.
4. Microbiology In "Fisheries Studies": Part-I. Mansur, M. A. 2010. Botomul (Publisher), Dhaka. 234-312 pp.
5. Practical food microbiology. edited by Diane Roberts, Melody Greenwood. 3rd ed. 2003.
6. AOAC (Association of Official Analytical Chemists) 1980. Official methods of analysis of Association of Official Analytical Chemists. Washington, USA.
7. B.S. Larsen & C.N. McEwen, (1988), Mass Spectrometry of Biological materials. Marcel Dekker Inc.
8. Barrow, G. I. and R. K. a. Feltham. 1993. Cawan and Steel's Manual for the Identification of Medical Bacteria. Cambridge University Press.
9. Collins, C. H., P. M. Lyne and J. M. Grange (Eds.). 1989. Microbiological methods. 6th Edition, Butterworth & Co. Ltd., Oxford.
10. G.W. Ewing, (1997), Analytical Instrumentation Handbook, Marcel Dekker Inc.
11. J.A, Peary. 1981. Introduction to Analytical Gas Chromatography, Marcel Dekker Inc.

MPO-823: Fishery Products and Quality Control
Full Marks: 100; Credit: 2

Course Description:

The course covers different fishery products with their uses and processing methods as well asquality, quality program, quality organization, quality assessment and official inspection practices. The course is designed to strengthen existing knowledge of students on application of different quality control program such as GMP, SOP, SSOP, HACCP used in fish and fishery products. This course can also teach them the standard specifications of fish products such as BSTI, Codex and ICMSF standards. This course also focuses the Bangladesh food laws along with EU, FDA, ITC, WTO, Japan standards for exporting fish and fishery products.

Course Objectives:
To provide students with the knowledge of use, processing method, quality assessment and official inspection practicesof different fishery products.

Learning Outcomes:
At the end of the course, the students will be able to- i) Know the different fishery products and their uses ii) Know the processing methods of fishery products iii) Ensure the proper utilization of fish and shellfish iv) Know the basic concepts of quality and quality control v) Know the application of modern approaches for quality control such as food laws, HACCP, Traceability and specific standards etc. vi) Determine the quality indicators in fish and fishery products, and vii) Know the official inspection procedure in industry level.

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

COs	Course Outcomes	Lectures
CO1	Describe the world fisheries resources and their utilization, scientific and technological development of fishery products.	3
CO2	Produce the frozen fish fillets, breaded fishery products, value-added frozen shrimp and fish products.	4
CO3	Categorize salted fish, shellfish, seaweed, fish roe; describe the process of salted hilsha in Bangladesh; categorize and describe the dried fishery products; differentiate and describe the production process of cold & hot smoked products, seasoned-smoked products; describe the production process of shrimp smoking in Bangladesh.	4
CO4	Describe the production process of canning of small fish (whole), Salmon and tuna canning, canned shellfish (crab, shrimp, and squid).	3
CO5	Describe the process of fermented fish paste or fish pickles, liquid fermented fish sauce, cured fermented products, semi-fermented product (Shidalshutki in Sylhet).	2
CO6	Describe the concepts of marinades; differentiate and describe the cold, cooked & fried –marinades with their manufacturing process, spoilage, and quality control.	2
CO7	Describe the surimi based products in terms of raw materials selection, preparation of Surimi, process evaluation; briefly describe the surimi based products including kamaboko, chikuwa, agemono, crab-meat analog, shrimp analog, beef analog, and other fabricated products.	2
CO8	Describe the preparation of fish sausage and ham, fish ball, fish stick, fish finger and fish burger.	2
CO9	Know the history of quality control, the traditional approach to quality control and the importance of quality programmes; describe and apply the modern approach to quality control such as GMPs (Good Manufacturing Practices), SOP (Standard Operating Procedure), SSOP (Sanitation Standard Operating Procedure).	3
CO10	Identify and explain the quality deterioration and quality defects in raw materials and finished products in terms of causes and effects, factors, and practical means of prevention.	3
CO11	Explain and assess the quality by the sensory, mechanical, instrumental, chemical, and microbial methods for fishery products.	4
CO12	Explain and apply the industrial quality control, official inspection, and requirements, licensing.	3
CO13	Explain and apply the hygiene and safety aspects of quality assurance, HACCP system, and traceability system in the fish processing industry.	3
CO14	States the standard specification of fishery products under different organization such as Codex Alimentarius commission (CAC), International Organization of Standardization (ISO-9000-4), International Commission of Microbiological Specification (ICMS), and Bangladesh Standard Testing Institute (BSTI).	3
CO15	Describe and apply food laws and regulations for fish and fishery products in Bangladesh; Outlines the requirement of exportable fish and fishery products by EU, FDA, ITC, UNCTAD/WTO, Japan and other fish and fishery products importing countries.	3

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	World fisheries resources and their utilization, scientific and technological development of fishery products.	Lectures followed by discussion	Full Marks: 100
CO2	Frozen fishery products: Frozen fish fillets, breaded fishery products, value-added frozen shrimp and fish products.	Lectures followed by discussion	
CO3	Cured fishery products: Salted fish - types of salted fish, shellfish, seaweed, fish roe, Salted hilsha in Bangladesh. Dried fish: sun-dried products, salt, boiled, broiled, freeze and seasoned-dried products, dried seaweed. Smoked fish: cold & hot smoked products, seasoned-smoked products, and shrimp smoking in Bangladesh.	Lectures followed by discussion	
CO4	Canned products: Canning of small fish (whole), Salmon and tuna canning, canned shellfish (crab, shrimp, and squid).	Lectures followed by discussion	
CO5	Fermented products: Fermented fish paste or fish pickles, liquid fermented fish sauce, cured fermented products, semi-fermented product (Shidalshutki in Sylhet).	Lectures followed by discussion	
CO6	Fish marinades: Concepts of marinades, cold, cooked & fried –marinades, manufacturing process, spoilage, and quality control.	Lectures followed by discussion	
CO7	Surimi based products: Raw materials selection, preparation of Surimi, process evaluation, surimi based products (kamaboko, chikuwa, agemono, crab-meat analog, shrimp analog, beef analog, and other fabricated products).	Lectures followed by discussion	
CO8	Paste products: Fish sausage and ham, fish ball, fish stick, fish finger and fish burger.	Lectures followed by discussion	
CO9	General principles of quality control: The history of quality control, the traditional approach to quality control. The modern approach to quality control. GMPs (Good Manufacturing Practices), SOP (Standard Operating Procedure), SSOP (Sanitation Standard Operating Procedure). The importance of quality programmes.	Lectures followed by discussion	
CO10	Quality deterioration and quality defects in raw materials and finished products: Causes and effects, factors affecting deterioration, practical means of prevention.	Lectures followed by discussion	
CO11	Methods of assessing the quality of fish and fishery products: Sensory methods, mechanical, instrumental, chemical and microbiological methods.	Lectures followed by discussion	
CO12	Organization of quality control and official inspection: Industrial quality control, official inspection, and requirements, licensing.	Lectures followed by discussion	

CO13	Industrial and commercial aspects of quality control: Hygiene and safety aspects of quality assurance; setting up the HACCP system in a seafood processing plant, quality systems, and audit checking. Traceability in the fish processing industry.	Lectures followed by discussion	
CO14	Standard specification of fish and fishery products: Bangladesh Standard and Testing Institute (BSTI), International Commission of Microbiological Specifications (ICMS); International Standard Organization (ISO-9000), Codex Alimentarius commission (CAC).	Lectures followed by discussion	
CO15	Food Laws and Regulations: General food law & regulations, FDA of America; European Union (EU) laws; International Trade Center (ITC), UNCTAD/WTO, Japan and requirement of other fish and fishery products importing countries.	Lectures followed by discussion	

Recommended books/ literature:

1. Hall, G. M. 1992. Fish processing Technology. Blackie Academic & professional, An Imprint of Chapman & Hall, London.
2. Stansby, M. E. 19990. Industrial Fishery Technology. Reinhold Publ. Corp., NY.
3. Tanikawa, E. 1985. Marine products of Japan. KoseishaKoseikaku Co. Ltd. Tokyo, Japan.
4. Claucas, I. J. (Editor) 1985. Fish Handling, Preservation and Processing in the Tropics. Part-I and II. 2nd edition. TDRI, London, ODA, U.K.
5. Rogenstein, J. M. 1991. Introduction to fish Technology. An Osprey Book. VanNostrand Reinhold, New York.
6. Wheaton, F. W. and T. B. Lawson. 1985. Processing of aquatic food products. Wily and Sons New York.
7. Introduction to Fishery By-products. M. Windson and S. Barlow (1911). Fishing News Books Ltd.
8. Control of Fish Quality. J. J. Connell (1980). Fishing News Books Ltd.
9. Marine Products in Japan. E. Tanikawa (1985). Koseisha Co. Ltd. Tokyo.
10. The Freezing Preservation of Foods. Donald (editor) (1968). The AVI Publ. Co. Inc.
11. The Technology of fish Utilization. R. Krenzer (1965). Fishing News Books Ltd. London.
12. On Testing the Freshness of Frozen Fish. G. J. A. Peter (editor) (1971). Fishing News Books Ltd. London.
13. Harvests and Post-harvest Technology of Fish. K. Rabindran (editor) (1985). Society of Fisheries Technologists, India.
14. Industrial Fishery Technology. M. E. Stausby (1963). Reinhold Publ. Corp. New York.

MPO-824: Modern Fish Feed Technology
Full Marks: 100; Credit: 2

Course Description:

The course covers the understanding of fish feed concerning feed ingredients sources, live feed, feed formulation, processing, feed industry and feed storage. This course focuses on proximate composition of dietary ingredients and naturally occurring toxins feedstuff. This course will also demonstrate different techniques and methodologies for fish feeding at field level.

Course Objectives:

To provide the knowledge of fish feed concerning feed ingredients sources, live feed, feed formulation, feeding methods, feeding rate and frequency along withnon-nutrient and anti-nutrient component, feed processing feed industry and feed storage.

Learning Outcomes:

At the end of the course, the students will be able to know about the fish feed ingredient of different sources, non-conventional feed, feed formulation, feeding methods, feeding rate, their application in fish ponds, non-nutrient and anti-nutrient component, natural and chemical contaminants of feed stuff, feed processing, feed storage and feed manufacturing plant.

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

COs	Course Outcomes	Lectures
CO1	Know the Fish Feed and their importance including the advantage and disadvantage in intensive and semi-intensive aquaculture.	1
CO2	Know and distinguish the plant and animal origin ingredients for fish feed and their proximate composition.	3
CO3	Discuss on the Live feeds like *Tubifex*, *Artemia*, *Daphnia*, *Moina*, rotifers etc.	4
CO4	Know the non-conventional fish protein sources such as Fish silage, fish meal, micro-encapsulated diets etc.	3
CO5	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.	4
CO6	Know how to Select the supplementary feeds and apply supplementary diet feeding techniques.	2
CO7	Apply different Feeding methods such as Broadcasting, feeder, demand and non-demand feeders, feed particles shape and size.	2
CO8	know different Types of fish feed with their classification based on the stage of life cycle, Product quality fish feed.	2
CO9	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.	2
CO10	Demonstrate the Fish feed preparation.	2
CO11	Describe non-nutrient component in fish feed.	2
CO12	Describe toxic constituents in feedstuffs: Antinutritional factors present in plant feedstuffs; adventitious toxic factors in feedstuffs.	2
CO13	Explain Natural and chemical contaminants of feed stuff	2
CO14	Categorizes antibiotics and probiotics in aquafeed, Feeding stimulants.	2
CO15	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.	2
CO16	Organize Feed industry in Bangladesh Status and problems of aquafeed industry, Floating and sinking feed manufacturing process. Nutritional quality of compounded feeds.	2
CO17	Understand feed storage and damage of fish feed and quality control.	2
CO18	Evaluate methods and utilize feed parameters: MWG, PWG, SGR, FCR, FCE, PER, NPU, ANPU and Digestibility.	2
CO19	Label specification for fish and shrimp feed: Quality aspects of protein source, Characteristics of potential feed ingredients. Fish and shrimp Feeds and legal aspects.	2
CO20	Create alternative Protein sources for fish feed: Plant and animal by-product, protein –sparing feeds and economically optimal dietary protein level	2

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	An introduction to Fish Feed and their importance and advantage in intensive and semi-intensive aquaculture.	-Lectures followed by discussion -Participatory question-answer -Online resources	Full Marks: 100
CO2	Fish Feed stuffs: Sources of plant and animal origin ingredients for fish feed and their proximate composition.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO3	Live feeds: *Tubifex*, *Artemia*, *Daphnia*, *Moina*, rotifers etc.	-Lectures followed by discussion -Participatory question-answer	
CO4	Non-conventional fish protein sources: Fish silage, fish meal, micro-encapsulated diets etc.	-Lectures followed by discussion -Participatory question-answer	
CO5	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 -Online resources	
CO6	Supplementary feed: Selection of supplementary feeds, Supplementary diet feeding techniques.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO7	Feeding methods: Broadcasting, feeder, demand and non-demand feeders, feed particles shape and size.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO8	Type of fish feed: Classification based on the stage of life cycle, Product quality fish feed.	-Lectures followed by discussion -Participatory question-answer	
CO9	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 -Online resources	
CO10	Fish feed preparation and presentation	-Lectures followed by discussion -Participatory question-answer	
CO11	Non-nutrient component in fish feed.	-Lectures followed by discussion	
CO12	**Toxic constituents in feedstuffs:** Antinutritional factors present in plant feedstuffs; adventitous toxic factors in feedstuffs.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO13	Natural and chemical contaminants of feed stuff	-Lectures followed by discussion -Participatory question-answer	
CO14	Antibiotics and probiotics in aquafeed,Feeding stimulants.	-Lectures followed by discussion -Participatory question-answer	
CO15	**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.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO16	**Feed industry:** Status and problems of aquafeed industry, Floating and sinking feed manufacturing process.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO17	**Feed storage**: Storage and damage of fish feed during storage and quality control.	-Lectures followed by discussion -Participatory question-answer	

CO18	**Feed evaluating and feed utilization parameters:** MWG, PWG, SGR, FCR, FCE, PER, NPU, ANPU and Digestibility.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO19	**Labeling specification for fish and shrimp feed:** Quality aspects of protein source, Characterestics of potential feed ingredients. Fish and shrimp Feeds and legal aspects.	-Lectures followed by discussion -Participatory question-answer -Online resources	
CO20	**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 -Online resources	

Recommended books/literature:

1. 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. Toxic Constituents of Plant Foodstuffs. D. E. Linear (editor). Academic Press, New York.
6. Feed and Feeding of Fish and Shrimp. M. B. New (1987). ACDP/REP/87/26 UNDP/FAO, Rome.
7. Feed and Feeding of Fish and Shrimp. M. B. New (1987). ACDP/REP/87/26 UNDP/FAO, Rome.

MPO-825: Fishery By-products Technology
Full Marks: 100; Credit: 2

Course Description:

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.

Course Objectives:

To provide students with the knowledge of different fishery byproducts with their uses and processing methods.

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-

COs	Course Outcomes	Lectures
CO1	Explain the scope of fishery by-product production, raw materials, abundance.	2
CO2	Explain the processing, preservation, quality deterioration and utilization of fishmeal.	2
CO3	Describe the processing, preservation, quality deterioration and utilization of fish oils.	2
CO4	Discuss the processing, preservation, quality deterioration and utilization of fish silage	2
CO5	Explain the Processing, preservation, nutritive value, deterioration and utilization of fish hydrolysate and fish protein concentrate.	2

CO6	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
CO7	Define and discuss the processing methods of the nutraceutical and pharmaceutical products: agar, alginic acid and alginate, iodine, mannitol, insulin.	3
CO8	Explain the extraction, storage and utilization of the taste and flavor active compounds in seafood	3

Lesson plan

COs	Course Contents	Teaching Strategy	Assessment Strategy
CO1	Scope of fishery by-product production, raw materials, abundance.	-Lectures followed by discussion -Participatory question-answer	Full Marks:100
CO2	Fishmeal, fish scrap and other seafood waste meal: Processing, quality deterioration, preservation, utilization, and nutritional value.	-Lectures followed by discussion -Participatory question-answer	
CO3	Fish oils: Fish oil processing – dry rendering & wet rendering methods; nutritive value; quality deterioration and preservation of fish oil.	-Lectures followed by discussion -Participatory question-answer	
CO4	Fish silage: Processing, preservation and utilization; quality and nutritional value.	-Lectures followed by discussion -Participatory question-answer	
CO5	Fish hydrolyzate and fish protein concentrate (FPC): Processing, nutritive value, deterioration, and preservation.	-Lectures followed by discussion -Participatory question-answer	
CO6	Specialty products: Gelatin, fish glue, caviar, roe and milt, leather, chitin, chitosan, dried shark's fin, pearl essence, pearl, ornamental shell, tortoise shell, and coral products.	-Lectures followed by discussion -Participatory question-answer	
CO7	Nutraceutical and pharmaceutical products: Agar, alginic acid and alginate, iodine, mannitol, insulin.	-Lectures followed by discussion -Participatory question-answer	
CO8	Taste and flavor active compounds in seafood: extraction, storage, and utilization.	-Lectures followed by discussion -Participatory question-answer	

Recommended books/ literature:

1. Hall, G. M. 1992. Fish Processing Technology. Blackie Academic & Professional, An Imprint f Chapman & Hall. London.
2. Lanier, T. C. and C. M. Lee (ed.) 1992. Surimi Process Technology, Marcel Dekker, Inc., New York.
3. Tanikawa, E. 1985. Marine products of Japan. KoseishaKosikaku Co., Ltd. Tokyo, Japan.
4. Rogestein, Joe, M. 1991. Introduction to Fish Technology. An Osprey Book. Van Nostrand Reinhold, New York.
5. Stansby, M. E. 1962. Industrial Fishery technology. Reinhold Publishing Corp., New York.
6. Wheaton, F. w. and T, B. Lawson. 1985. Processing of aquatic food products. Wiley and Sons, New York.
7. Ravindran, K., N. Nair., I. A. Parigreen., P. A. Panicker and M. Thomas. 1985. Harvest and post-harvest Technology of fish. Society of Fisheries Technologists, India.
8. Stansby, M. E. 1990. Industrial Fishery Technology. Reinhold Publ. Corp., NY.
9. Tanikawa, E. 1985. marine products of Japan. KosheishaKoseikaku Co., Ltd, Tokyo, Japan.
10. Frazier, W. C. and D. C. Westhoff. 1990. Food Microbiology. 3rd Edition. McGraw Hill Book Co., New York, London.
11. Kiss, I. (Ed.) 1984. Testing Methods in Microbiology. Elsevier Science Pub; Netherlands.