FACULTY OF FISHERIES

COURSE LAY OUT AND SYLLABUS

OF

B.SC.Fisheries (Hons.) DEGREE

Level -2

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY
DINAJPUR

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Course Layout of B.Sc. Fisheries (Hons.) Degree

	Semesters					
Level /Year	Semester-I			Semester-II		
	Course Title	Course Code	Credit Hour (T+P)	Course Title	Course Code	Credit Hour (T+P)
1	**Compulsory**			**Compulsory**		
	Fisheries Zoology	FBG 101, 102	3+1.5	General Ichthyology	FBG 103, 104	3+1.5
	Aquatic Ecology	FMG 101, 102	3+1.5	Fresh Water Aquaculture	AQC 103, 104	3+1.5
	Chemistry	ACH 107, 108	3+1.5	Physico-Chemical Limnology	FMG 103, 104	3+1.5
	Rural Sociology	SSL 103	3+0	Biochemistry	ACH 109, 110	3+1.5
	Elective (any one)			**Elective (any one)**		
	English Language	SSL 105	2+0	Computer Science	CIT 111	2+0
	Introductory Aquaculture	AQC 103	2+0	Aquatic Soil Science	FMG 105	2+0
	Total Credit		**14+4.5=18.5**	**Total Credit**		**14+6=20**
	Semesters					
2	Semester-I			Semester-II		
	Compulsory			**Compulsory**		
	Biodiversity and Fishery Systematics	FBG 201, 202	3+1.5	Fish Parasitology	AQC 205, 206	3+1.5
	Coastal Aquaculture	AQC 201, 202	3+1.5	Fish Population Dynamics-I	FMG 203	3+0
	Fisheries Microbiology-I	FTL 201	3+0	Principles of Genetics	FBG 204, 205	3+1.5
	Statistics	STT 205, 206	3+1.5	Fisheries Microbiology-II	FTL 203	3+0
	Biological Limnology	FMG 201, 202	3+1.5	Fisheries Microbiology	FTL 204	0+1.5
	Elective (any one)			**Elective (any one)**		
	GIS in Fisheries	AQC 203	2+0	Live Food Culture	AQC 207	2+0
	Shell fish Biology	FBG 203	2+0	Aquatic Environmental Science	FMG 205	2+0
	Total Credit		**17+6=23**	**Total Credit**		**14+4.5=18.5**
	Semesters					
3	Semester-I			Semester-II		
	Compulsory			**Compulsory**		
	Fish Pathology	AQC 301, 302	3+1.5	Fish Nutrition	AQC 303, 304	3+1.5
	Fish Population Dynamics-II	FMG 301	3+0	Fish Farm Design and Construction	AQC 305, 306	3+1.5
	Fish Population Dynamics	FMG 302	0+1.5	Oceanography and Marine Biology	FMG 303, 304	3+1.5
	Fish Physiology	FBG 301, 302	3+1.5	Fish Processing	FTL 305, 306	3+1.5
	Fish Harvesting	FTL 301, 302	3+1.5			
	Elective (any one)			**Elective (any one)**		
	Fishery by-products	FTL 303	2+0	Marine Food Chemistry	FTL 307	2+0
	Biology of Farmed Fishes	FBG 303	2+0	Culture of Ornamental Fish	AQC 307	2+0
	Total Credit		**14+6=20**	**Total Credit**		**14+6=20**

COURSE LAYOUT

Level /Year	Course Title	Course Code	Credit Hour (T+P)	Course Title	Course Code	Credit Hour (T+P)
	Semesters					
4	Semester-I			Semester-II		
	Compulsory			**Compulsory**		
	Fish Genetics and Breeding	FBG 401, 402	3+1.5	Hatchery Management	FBG 403, 404	3+1.5
	Fish Feed Technology	AQC 401, 402	3+1.5	Fish Health Management	AQC 405, 406	3+1.5
	Inland Fisheries Management	FMG 401, 402	3+1.5	Fisheries Extension		3+1.5
	Quality Control of Fishery Products	FTL 401, 402	3+1.5	Marine Fisheries Management	FMG 405, 406	3+1.5
	Fisheries Economies	ECN 407	3+0	**Elective (any one)**		
	Elective (any one)			Principles of Molecular Biology & Biotechnology	FBG 405	2+0
	Integrated Aquaculture	AQC 403	2+0	Sustainable Livelihood Approach (SLA)	FMG 407	2+0
	Fisheries Resources	FMG 403	2+0			
	Total Credit		**17+6=23**	**Total Credit**		**14+6=20**

Credit required for Theoretical : 118
Credit required for Practical : 45
Total Credit required : 163

Level 2, Semester – I

Department of Fisheries Biology and Genetics

Course No. FBG 201
Course Title: Biodiversity and Fishery Systematics
Theoretical : 3 Cr.

Introduction: Course goals, objectives and outcomes.
Basic information on biodiversity : Definition of species. Ecosystem and genetic diversity. The nature and value of biodiversity- economic and ecological.
Aquatic biodiversity study: Species biodiversity Ecosystem diversity -
Country level: Inland – ponds, swamps, lakes, canals and rivers and Marine – Bay of Bengal, coast, off-shore and estuaries
Global level: Hydrosphere (7 oceans), Lithosphere (lands – 5 continents) and Atmosphere (Air), Rhythms: Scalar rhythm (24 h diurnal), Lunar rhythm (monthly) and solar rhythm (annual), wave and current
Loss of the biodiversity: Causes; natural variation in time and space; Present situation, endangered aquatic species of Bangladesh.
Systematics - an overview.
Taxonomic characters: Morphometric, meristic, physiological, ecologicald and ethological.Criteria for taxonomic categorization.
Zoological nomenclature: The rules of Zoological nomenclature: International code, validity of names, homonymy, synonymy.
Mechanisms of speciation: Species concepts and speciation in fish.
Evolution and adaptive radiation in fish: Agnatha, chondrichthyes, primitive fishes, teleosts and acanthopterygii.
10. Recent developments in systematics.

FBG 202: Biodiversity and Fishery Systematics

Practical : 1.5Cr.

Students shall maintain a record of everything done in the practical and field sessions in a Practical Note Book to be signed and checked by teacher(s) concerned.

Viva voce test will form an essential part of the Practical Examinations.
Collection and preservation of aquatic animals.
Characterization and identification of collected specimens.
Study of morphometric and meristic characters of fishes.
Study of biodiversity of selected and protected areas.

Text Books and references:

1. Mayr, E., 1969. Principles of Systematic Zoology. McGraw Hill Book Co. New York
2. Helfman, G.S., Collette, B.B. and Facey, D.E., 1997. The Diversity of Fishes. Blackwell Science.
3. Gaston, K.J. and Spicer, J.I., 1998. Biodiversity - An Introduction. Blackwell Science.
4. Day, F., 1971. The Fishes of India. Today and Tomorrows Book Agency, New Delhi.
5. Mayr, E., 1963. Animal species and evolution. The Belknap Press, Harvard University Press, Cambridge.
6. Misra, K.S., 1962. An aid to the identification of the common commercial fishes of India and Pakistan. In. Rec. Indian Mus. Vol. 57.
7. Rahman, A.K.A., 1989. Freshwater Fishes of Bangladesh. The Zoological Society of Bangladesh. Dhaka 1000.
8. Shafi, M. and Kuddus, M.M.A., 1982. Bangladesher Matsya Sampad (Bangla) Bangla Academy, Dhaka.
9. Lagler, K.F. Bardach, J.E., Miller, R.R. and Passino, D.R.M., 1977. Ichthyology. John Wiley and Sons, New York.
10. McNeely, J.A. and Somchevita, S. (eds.), 1996. Biodiversity in Asia: Challenges and Opportunity for Scientific Community. Proceedings of a Conference on Prospects of Cooperation on Biodiversity Activities. OEPP, MSTE, Bangkok, Thailand.
11. IUCN, 1996. The Multiple Dimension of Biodiversity. The World Conservation Union, Gland, Switzerland.
12. Brown, K., Pearce, D., Perrings, C. and Swanson, T., 1993. Economics and the Conservation of Global Biological Diversity. Working Paper No. 2. UNDP, UNEP & World Bank.
13. Castilleja, G., Poole, P.J. and Geisler, C.C., (Shelton, H.D. ed.), 1993. The Social Challenge of Biodiversity Conservation. UNDP, UNEP & World Bank Working Paper No. 1.
14. Ponniah, A.G. and Sarker, U.K., 2001. Fish Biodiversity in North East India. National Bureau of Fish Genetic Resources, India.
15. Glowka, L., Pisupati, B., and de Silva, S., 2001. Access to Genetic Resources and Benefit Sharing. IUCN.

Department of Aquaculture

Course Code : AQC 201
Course Title: Coastal Aquaculture
Theoretical : 3 Cr.

1. Introduction: History of coastal aquaculture, global, regional and national importance of coastal aquaculture.
2 Site selection: Soils, Coastal environment, Coastal ecosystem, Water movement (tides, current, waves).
3. Use of GIS to determine suitability of aquaculture site to avoid conflicts.
4. Culture of finfishes: Seabass, mullet, milk fish, and salmon.
5. Culture of crustaceans: prawns, crabs, Shrimp, lobster.
6. Culture of mollusks: Mussels, clams, and oyster.
7. Culture of seaweeds.
8. Polyculture: Fish and shrimp culture with rice.
9. Mangrove forest and aquaculture:
    i. Mangrove ecosystem
    ii Impact of deforestation
    iii Management of mangroves for sustainable fisheries and aquaculture.
10. Coastal aquaculture constraints, planning and mitigation measure

AQC 202 : Coastal Aquaculture

Practical : 1.5 Cr.

The students should have maintained a record of everything done in practical and field sessions a practical notebook to be signed and checked by teacher (s) concerned. Viva-voce test will be from an essential part of practical examination.

Course content of practical classes

1. Designing of a coastal shrimp and fish farm
2. Use of GIS for selecting site for coastal aquaculture
3. Transportation of larvae and PL of shrimp
4. Nursing of prawn and shrimp fry
5. Demonstration of culture techniques for oysters, mussels and clams
6. Decapsulation and hatching of *Artermia* in laboratory condition
7. Case study: Visit to a coastal aquaculture farm

Text Books and References:

Arlo, W.F.and Lester L.J.1992 .Marine Shrimp Culture: Principles and Practices. ELSEVIER Science Publishers 882 pp.

2 De Silva, S. S.1998. Tropical Mariculture Academic Press 487 pp.

3 Pillay, T.V.R. 1972.Coastal Aquaculture in the Indopacific Region Fisheries Fishing News (Books) Ltd. London. 497 pp.

4 Anonymous. 1985. Shrimp culture in the semisaline zone of the Delta. Final Report, Technical Report No. 13, Vol. 1. Aruhem. The Hague 60 pp.

Bardach, J. E. J. H. Ryther, and Mclarney, W. O. 1972. Aquaculture. John Willey & Sone. Inc. New York

Imai, T. 1977. Aquaculture in shallow seas: Progress in shallow sea culture. Oxford. BH Publishing Co. New Delhi, Bombay, Calcutta. 615 pp.

Islam, A. 1988. Samudra Upakula Matsya Chash. Bangla Academy, Dhaka, 115 pp.

Kurian C. V. and V. O. Sehastian 1978. Prawn and Prawn fisheries of India, Hindustan Publishing Corporation, Delhi.

Lee, D. O. C. and J. F. Wiehins, 1991. Crustacean Farming. Oxford, Fishing News Books/Blackwell Scient. Publ. Ltd.

McVey, J. and J. Moore, 1983. CRC Hand book of Mariculture. Vol. I: Crustacean Aquaculture.

McVey, J. 1991. CRC Hand Book of Mariculture. Vol. II. Fin fish Aquaculture.

Mohan, M. J. (edited). 1980. Aquaculture in Asian Fisheries Society, Indian Branch Mangalore.

Muir, J. F. and R. J. Roberts (edited). 1982. Recent Advances in Aquaculture. Vol. 1. Croom Helm, London. 453 pp.

Muir, J. F. and R. J. Roberts, 1985. Recent Advances in Aquaculture. Vol. 2. Beckenham, U. K., Croom Helm, 282 pp.

Muir, J. F. and R. J. Roberts, 1988. Recent Advances in Aquaculture, vol. 3. Beckenham, U. K., Croom Helm, 420 pp.

New, M. V. and S. Singholka. 1982. Freshwater Prawn Farming. A. manual for the culture of FAO Fish. Tech. Paper. (225): 116 pp.

Shigeno, K. 1978. Problems in prawn culture Amerind Publishing Co., PVT. Ltd. New Delhi.

Department of Fisheries Technology

Course Code No: FTL 201

Course Title: Fisheries Microbiology-I

Credit hour: 3 Cr.

Introduction: Scope, historical development, ecology and geographical distribution.

Taxonomic classification of microorganisms: Mold, yeast, bacteria, mycoplasma, chlamydia, virus and rickettsia. General characteristics of prokaryotes and eukaryotes.

Molds and yeasts: General morphology, structural and reproductive characteristics, cultural characteristics, physiological characterises, distinguishing characterises of important genera and industrial importance.

Bacteria: Morphology and structure (cell wall, cell membrane, capsule, pilli, flagella, spores, cytoplasm, and nuclear material). Cultural and physiological characteristics. Description of important genera.

Viruses: General characteristics, classification, morphology and structure, viral reproduction.

Microbial growth and nutrition: Microbial growth curve, factors affecting microbial growth (water activity a_w , pH, temperature, redox-potential E_h, nutrient, microbial interactions, antimicrobial agents).

Immunity: Antigen, antibody, antigen-antibody reactions (agglutination, precipitation, complement fixation and cytolysis, phagocytosis, hypersensitivity), Immunological methods (FAT, ELISA).

Antibiotic, antiseptics and disinfectants: Definition, types, characteristics, mode of action and economic importance.

Text books and reference:

1. Alcamo, I. Edward, 1984. Fundamentals of Microbiology. Addison-Wesley Publishing company.
2. Burrows, W. 1985. Textbook of Microbiology. 22nd Ed. W. B. Saunders Co., Philadelphia and London.
3. Franklin, T. J. and Snow, G. A. 1971. Biochemistry of Antimicrobial Action. Chaoman and Hall, London.
4. Frazier, W. C. and Westhoff, D. C. 1990 Food Microbiology. 3rd edition. McGrow Hill Book Co., New York, London.

Department of Statistics

Course Code: STT 205,
Course Title: Statistics
Theoretical : 3 Cr.

Definition and scope of statistics, Variables, Construction of frequency distribution and graphical representation of data. Measures of central tendency, dispersion, Moments, Skewness and kurtosis. Elementary theory of probability, laws of probability, Probability distribution: Binomial, Poisson and Normal distribution, Fitting of Binomial and Poisson distributions to observed data. Population and sample. Preliminary idea on sampling distribution. Simple correlation and regression. Fitting simple linear regression to observed data.

Hypothesis, test of hypothesis, type-I and type-II errors and level of significance. Preliminary idea on t-test, F-test, chi-square test and their applications. Testing hypothesis regarding population mean, equality of two means, population variance, equality of two population variances, goodness of fit and independence of two attributes in contingency table and test of significance of correlation coefficient and regression coefficients.

Principles of experimental design, Field layout and analysis of variance in completely randomized design, randomized block design and Latin square design, Analysis of covariance in a completely randomized design, randomized block design.

STT 204 : Statistics
Practical : 1.5

Construction of frequency table and graphical representations of data, Calculation of various measures of central tendency, Quartiles, various measures of dispersion, Fitting Binomial and Poisson distributions to observed data. Calculation of correlation coefficient and fitting simple linear regression to observed data.

Testing hypothesis regarding population mean, testing significance of simple correlation coefficient and regression coefficient(s). Use of chi-square for testing goodness of fit and test of independence of attributes in a contingency table.

Field layout, analysis of variance and interpretation of data collected in completely randomized design, randomized block design and Latin square design with multiple comparison tests, Examples of covariance analysis in a completely randomized design and randomized block design.

Recommended Books:

1. Ahmed A.R. M.A.A. Bhuyan and Z.A Reza: Methods of Statistics. Shamsun Nahar Ahmed et al, 2004
2. Gomez, K.A and Gomez: Statistics Procedures for agricultural Research, John Wiley A.A and Sons, New York.
3. Shill,R. N. and Debnath,: An Introduction to the Theory of Statistics, 2nd ed, Azadi S.C. Printers Limited, Kalurghat, Chittagong.
4. Islam M.N. : An Introduction to Statistics and Probability, Third Edition, Book World, New Market, Dhaka.
5. Ahmed A.R. M.A.A. Bhuyan and Z.Hossain: Experimental Designs: Thoery and Application. Shamsun Nahar Ahmed et al, 2003
6. Gupta S.C. and Kapur, : Fundamentals of applied statistics S. Chand and Sons New V K Delhi
7. Jalil M.A. and Rezina Ferdous: Basic Statistics; Methods and Applications, Robi Publications, Dhaka Bangladesh.
8. Ali, Md.Ashraf :Theory of Statistics Vol.1 &11, Dhaka Book Mart, Dhaka.
9. Cochran, W. G :Sampling Technique, John Wiley and Sons, New York.
10. Chatterjee, S. and Price, B.: Regression Analysis by Example, John Wiley and sons, New York.

11. Draper N.R and Smith, H: Applied Linear Regression, 2nd de., John Wiley and Sons, New York.

12. Federar, W.T : Experimental Design:Theory and application, Oxford and IBH Publishing Co. New Delhi - Bomby - Calcutta.

13. Mead, R and Kurnow, R.N : Statistical methods in agricultural and experimental Biology, chapman and Hall, London -New York.

14. Das, M.N and Giri, N.C. :Design Analysis of Experiments. John Willey and Sons, New York.

15. Kempthrone, O, 1952: Design and analysis of Experiments John Willey and Sons, New York.

Department of Fisheries Management

Course Code: FMG 201
Course Title: Biological Limnology
Theoretical : 3 Cr.

1. **Introduction:** Biological relations in inland waters; classification of freshwater aquatic organisms of both lotic and lentic habitats.
2. **Phytoplankton:** Definition; Characteristics of major groups; morphology, life history, flotation; cosmopolitanism of freshwater plankton, distribution; seasonal succession; phytoplankton association; interactions with other organisms; relations between producers and consumers; effects of fertilization on phytoplankton.
3. **Eutrophication and harmful algae:** Eutrophication; causes of eutrophication; types of eutrophication; control and preventive measures of eutrophication; noxious and harmful algae; phytoplankton bloom; different types of harmful algal blooms; impacts of harmful algae on fish, other aquatic animals and human being; preventive and control measures.
4. **Aquatic primary production:** Definition; factors affecting primary production; estimation of primary production, variations of primary productions in different habitats.
5. **Zooplankton:** Definition; characteristics of major groups, seasonal variations in abundance. Food and feeding habits, reproduction biology, diurnal vertical migrations, cosmopolitanism, cyclomorphosis, relations with other organisms, phytoplankton-zooplankton relations. Culture of zooplankton.
6. **Benthos:** Definition, significance of benthos; benthic regions; qualitative and quantitative distribution; factors affecting distribution of benthos; life cycles of some common benthic fauna; bioturbation and its effects on productivity.
7. **Secondary production:** Definition; factors affecting secondary production; estimation of secondary production (zooplankton, benthos); variations of secondary production in different habitats.
8. **Periphyton (aufwuchs):** Definition; characteristics of major groups, seasonal variations in abundance; substrates, distribution in lentic and lotic habitats; importance in the ecosystems and relations with other organisms.
9. **Aquatic vascular plants:** Definition; major groups available in freshwater (closed and open systems); role in the floodplain and oxbow lake systems; influence on biological production; economic and aesthetic importance.

FMG 202 : Biological Limnology

Practical: 1.5 Cr.

Students shall be required to show a good knowledge of the topics included in the theoretical portion of the paper. They shall maintain a record of everything done in the practical classes/field trips in a practical note book to be signed and checked by the teacher(s) concerned.

Collection, preservation, identification and estimation of phytoplankton, zooplankton and benthos.

Quantitative sampling of plankton, periphyton and benthos from lentic and lotic waters.

Estimation of primary production using light and dark bottle method.

Estimation of plankton standing crop by pigment analysis (Chlorophyll-*a*).
Demonstration of techniques of plankton culture (phytoplankton and zooplankton).

Viva-voce test will form an essential part of the practical examination.

Text books and references:

1. A.P.H.A., 1976. Standard methods for the examination of water and wastewater including bottom sediments and sludge. 14th Ed. APH, New York.
2. Barber, H.G. and Haworth E.Y., 1981. A Guide to the Morphology of the Diatom Frustule. Freshwater Biological Association; Publication No. 4. Scientific Publication. Wilson & Son Ltd., Britain.112 pp.
3. Bellinger, E.G., 1992. A Key to Common Algae. The Institute of Water and Environmental Management. John Street, London. 138 pp.
4. Boney, A.D., 1975. Phytoplankton, Institute of Biology Study. 52, Crane, Russak Co, New York. 116 pp.
5. Boyd, C. E., 1979. Water quality in Warmwater Fish Ponds. Auburn University Agricultural Experiment Station, Auburn, Alabama, 359 pp.
6. Downing J.A. and Rigler, F.H., 1984. A Manual of Methods for the assessment of secondary productivity in freshwater. IBP Publication no. 17. Blackwell Scientific Publications.
7. Goldman G.R and Horne, A.J., 1983. Limnology. McGraw-Hill Book Co.
8. Hutchinson G. E., 1967. A Treatise on Limnology Vol. 2. Introduction to lake Biology and Limno plankton. John Willey & Sons., Inc., New York.
9. Jeffrey, S.W., Mantoura R.F.C. and Wright S.W., 1997. Phytoplankton Pigments in Oceanography: guidelines to modern methods. Sponsored by SCOR and UNESCO, pp. 19-445.
10. LeCren, E.D., Lowe-MxConnel, R.H., 1980. The Function of freshwater ecosystems. IBP publication No. 22. Cambridge University Press.
11. Moss B., 1988. Ecology of freshwater: Man and Medium. 2nd Ed. Blackwell Scientific Publications.
12. Reynolds, C.S. 1984. The Ecology of Freshwater Phytoplankton. Cambridge Studies in Ecology. Cambridge Univ. Press. London. 384 pp.
13. Stirling, H.P. 1985. Chemical and Biological Methods of Water Analysis for Aquaculturists. Institute of Aquaculture. University of Stirling, Scotland. 119 pp.
14. Ward, H.B. and G.C. Whipple. 1959. Freshwater Biology. 2nd ed. (Ed. by W.T. Edmondson). John Waley & Sons Inc., New York.
15. Wetzel E.G. 1983. Limnology. 2nd Ed. CBS College Publishing. The Dryden Press. New Your. 767+110 pp.

Department of Aquaculture

Course No: AQC 203 (Theoretical)

Course Title: GIS (Geographical Information Systems) in Fisheries

Credit hour: 2

Introduction: Definition, history and components of GIS.

Spatial data: Mapping concepts, features and properties, maps and their influence on the character of spatial data. Data types: point, line and polygon. Vector and raster data, advantages and disadvantages. Other sources of spatial data. Census and survey data, aerial photographs, satellite images. Field data sources. Surveying and GPS.

Data input, verification, storage, and output: Methods of data input, editing, presentation, updating and storage.

Data analysis: Measurement in GIS. Lengths, perimeters and areas. Reclassification, buffering and distance. Vector to raster and raster to vector transformation. Integrating data into GIS – map overlay, spatial interpolation and their use in fisheries.

Multi criteria evaluation (MCE): Fish habitat suitability modelling (FHSM) for different fish species, mapping fish species and plankton distributions in lake, estuaries and sea using available information and satellite images. Detection of existing fish farming locations using satellite images.

Use of GIS for aquaculture planning and development.

Case Study: Fish habitat suitability modelling in different environmental conditions.

Text and reference books:

Star, J. and Estes J. (1990). Geographical Information Systems: An Introduction. Prentice Hall, Englewood Cliffs.

Mathews Hugh and Foster Ian (1995). Geographical Data, sources, presentation and analysis. Oxford University Press.

Heywood, I, Cornelius S. and Carver S. (1998). An introduction to Geographical Information Systems. Longman, London.

Aguilar, M.J. and Nath, S.S. (1998). A strategic reassessment of fish farming potential in Africa. Food and Agriculture Organisation, Rome, Italy.

Antenucci, J. C. et al. (1991). Geographic Systems. A guide to the Technology. Van Nostrand Reinhold, New York.

EGIS (1997). Floodplain fish habitat study, Water resources planning organisation (WARPO), Ministry of water resources, Government of Bangladesh, Dhaka, Bangladesh.

Hugh Mathews and Ian Foster (1995). Geographical Data, sources, presentation and analysis. Oxford University Press.

Ian Masser and Michael Blakemore (1991). *Handling Geographic Information*: Methodology and Potential Application. Longman Scientific and Technical, John Willy and Sons, Inc. New York.

Kapetsky, J.M. (1994). A strategic assessment of warm-water fish farming potential in Africa: CIFA TECHNICAL PAPER 27, Food and Agriculture Organisation, Rome, Italy.

Manfred M. Fischer and Peter Nijkamp (1993). Geographic Information Systems, Spatial Modelling and Policy Evaluation. Springer-Verlag, Berlin Heidelberg, New York, London, Paris, Tokyo, Hong Kong, Barcelona and Budapest.

Nancy J. Obermeyer and Jeffrey Pinto (1995). Managing Geographic Information Systems. The Guiford Press. New York, London.

William, J. Douglas (1995). Environmental GIS Application to industrial facilities. Lewis Publishers, Boca Raton, Ann Arbor, London, Tokyo.

GIS Journals: International Journal of GIS.

Photogrametric Engineering and Remote Sensing.

Department of Fisheries Biology and Genetics

Course No. FBG 203

Course Title: Shellfish Biology

Theoretical: 2 Cr.

Introduction: Course goals, objectives and outcomes.
Shellfish resources and their role in the economy of Bangladesh.
Factors affecting the life of shellfishes in aquatic environment.
Morphological features and biology with special reference to food and feeding habits, digestion, respiration, reproduction, embryonic and larval developments and shell formation of:
(a) Freshwater giant prawn; (b) Marine shrimp; (c) Mudcrab; (d) Octopus; (e) Lobster, and (f) Oyster.

Adaptation of shellfish in relation to food and feeding, respiration, reproduction osmoregulation and migration.

Text Books and references:

Mantel, L.H., 1983. The Biology of Crustacea Vol. 5. Internal Anatomy and Physiological Regulation. Academic Press Inc. 111 Avenue New York.

Provenzano, A.J. (ed.), 1985. The Biology of Crustacea Vol. 10. Economic Aspects, Fisheries and Culture. Academic Press Inc. Sandiego, New York, Boston. London.Tokyo.Toronto.

3. Angell, C.L., 1986. The Biology and Culture of Tropical Oysters. ICLARM, Manila, Philippines.
4. Green. J., 1961. A Biology of Crustacea. Quadrangle Books Inc.
5. Vernberg F. J. and Vernberg, W. B., 1983. The Biology of Crustacea. Vol. 8. Environmental Adaptations. 111 Avenue, New York.
6. Jordan E. L. and Verma, P. S., 1985. Invertebrate Zoology. S. Chand & Company, Ramnagar, New Delhi.
7. Kotpal R. L., 1997. Phylum Arthropoda. Rastogi Publication, Shivaji. Rd. Meerut. India.
8. Kotpal R. L, 1997. Mollusca . Rastogi Publication, Shivaji. Rd. Meerut. India.

Semester - II

Department of Aquaculture
Course Code : AQC 205
Course Title: Fish Parasitology
Theoretical: 3 Cr.

1. **Introduction to parasitology:** Definition. Symbiosis and its types, infestation and infection.
2. **Parasitic fauna of freshwater and marine fishes:** Classification of protozoan, helminth, copepod and annelid parasites of fishes; their characteristics and examples.
3. **Ecology of parasites:** Host-parasite-environment relationship, types of parasitism.
4. **Life cycles of representative protozoan and metazoan fish parasites:** key to their control.
5. **Common protozoan parasitic diseases of fishes:** causative agents, clinical and pathological signs, prevention and control measures.
6. **Common metazoan parasitic diseases of fishes:** causative agents, signs, pathology, prevention and control measures.
7. **Hosts reaction to parasites:** cell and tissue reactions. Immunity in fishes against parasitic infestation and infection. Principles of immunization against protozoan and metazoan parasitic diseases in fishes.
8. **Physiological factors of parasitic diseases:** stress and susceptibility of fish to parasitic diseases. Infestation to infection and diseases.
9. **Fish consumption and public health:** Fish as carrier of human diseases - zoonotic diseases. Prevention and control of zoonotic diseases.

AQC 206: Fish Parasitology
Practical: 1.5

Students shall maintain a record of everything done in the practical and field sessions in a practical note book to be signed and checked by teacher (s) concerned. Viva voce test will form an essential part of the practical examination.

1. Calibration of the microscope for measurements
2. Study of museum specimens of fish parasites.
3. Plan data accessation for examination of vertebrate host
4. Technique of investigation of fish host for parasitological study
5. Collection, fixation, and preservation of parasites.
6. Permanent preservation of parasites--staining, dehydration, clearing and mounting
7. Key out, identification and description of collected parasites
8. Field trip: to a fish farm and preparation of report on parasitological investigation.

Text and reference books:

1. Cheng. T. C. 1982. General Parasitology Academic Press, Inc.
2. Dogiel, V.A. 1962. General Parasitology. Oliver and Boyd, Edinburgh, U. K.
3. Kabata, Z. 1985. Parasites and diseases of fish cultured in the tropics. Taylor and francis, London.
4. Woo, P.T.K. (Ed.) 1995. Fish diseases and disorders. Vol. I. Protozoan and metazoan infections. CAB, international.
5. Esch, G.W., Bush, A. O. and Aho J. M. 1990. Parasite communities : Patterns an Processes. Chapman and Hall, London.
6. Kennedy C.R.1975. Ecological Animal Parasitology. Blackwell Scientific Publications, Oxford.
7. Williams, H.H. and Jones, A. 1994. Parasitic Worm of fish. Tayler and Francis, Basingstocke.
8. Kennedy, C.R. 1976. Ecological Aspects of Parasitology. North Holland, Amsterdam.
9. Roberts R. J. 1989. Fish Pathology (2nded.) Baillere Tindal, London, UK.
10. Chandratchakool, P., Tuabull, J. F. and Limsuwan, C. 1994. Health Management of Shrimp Ponds .Aquatic Anima lHealth Reseaech Institute Bangkok, Thailand.
11. Lom, J. and I. Dykova. 1992. protozoan parasites of fishes. Development in aquaculture and Fisheries Science, 26. Elsevier, Amsterdam.
12. Hoffman, G.L. 1967. Parasites of North Americal Freshwater Fishes.University of California Press, Burkeley .
13. Cable. R.M. 1963. An illustrated Manual of Parasitology. Allied Pacific Private Limited, India.
14. Tonguthai,K., Chinabut, S., Somsiri, T., Chanratchakool, P. and Kanchanakhan, S. Diasnostic Procedures for Finfish Diseases. AAHRI, Department of Fisheries, Kasetsart Univ. Campus, Bangkok, Thailand.
15. Yamaguti, S. (1958, 1959, 1961, 1962, 1963) . Systema Helminthum . Vol. I – V.

Interscience Publishers Inc.

Department of Fisheries Management
Course Code No. FMG 203
Course Title: Fish Population Dynamics- I
Theoretical: 3 Cr.

Introduction: Definition, scope and importance

Distribution and unit stock: Distribution- the concept of unit stock, identification and separation of unit stock by various methods, spacing within a unit stock

Abundance: Relative and absolute abundance of population and their estimations

Size relationships: Linear regression, Length-weight relationships

Selectivity of fishing gear: Covered codend experiments, Alternate haul experiments

Marking and Tagging: Objectives, type of marking methods, types of tagging (external & internal), tagging materials and choice of marking methods, acquaintance with tags commonly used for marking fish

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 and computer-based analyses

Effects of exploitation: Effects of exploitation on size, age, species composition, catch per unit effort, economic level of abundance, area of eggs and young distribution, recruitment, equilibrium yield and shifting of fishing grounds

Level-2, S-II

Department of Fisheries Biology and Genetics

Course Code: FBG 204

Course Title: Principles of Genetics

Theoretical: 3 Cr.

Introduction: Course goals, objectives and outcomes. Historical background of genetics, branches of genetics, scope and significance of genetics.

Mendelian genetics: Mendel and his work; Mendel's laws of inheritance; principles of segregation; principles of independent assortment; deviations from Mendel's findings, lethal genes, peneterance, expressivity and pleiotropism. Examples for ornamental fishes.

Interaction of genes: epistatic and non-epistatic interaction, dominant and recessive epistasis. Multiple allelism.

Physical bases of heredity: Cell, prokaryotic and eukaryotic, cytoplasm, nucleus, chromosomes; cell division; cell division cycle; the chromosome theory of inheritance; chromosome structure; gametogenesis.

Linkage and crossing over: Difference in linkage and independent assortment. Kinds of linkage. Arrangement of linked genes. Crossing over and meiosis. Genetic recombination.

Sex-linked, sex-influenced and sex-limited inheritance: Sex-linked traits; sex-influenced traits and sex-limited traits in fishes.

Mutation: Morphological and biochemical levels. Classification of mutation; practical application of mutations.

Chemistry of the gene: Nucleic acids and their structure; synthesis, modification and repair of DNA. Packaging of DNA as nucleosomes.

Phenotypic expression of gene: protein synthesis; the genetic code; properties of genetic code. Transcription and translation.

FBG 205: Principles of Genetics
Practical : 1.5

Students shall maintain a record of everything done in the practical and field sessions in a Practical Note Book to be signed and checked by teacher(s) concerned.

Viva voce test will form an essential part of the Practical Examinations.

1. Familiarization with the practical courses and facilities of the department for the practical classes.
2. Study of chromosomes: Collection of fish larvae/fry and treatment with colchicine; Fixation of the fry in fixatives; Preparation of chromosome spreads, staining and observation under microscope.
3. Familiarization with the technique of genomic DNA isolation from fish tissues/embryos.
4. Study of inheritance of qualitative phenotypes: Setting up of aquarium and maintenance of small aquarium fish for spawning. Collection of the offspring and sorting them in to different phenotypic groups, statistical analysis of the phenotypic ratio obtained for goodness of fit by Chi-square test.

Text Books and references:

1. Gupta, P.K., 2000. Genetics (3rd edition). Rastogi Publications.
2. Gardner, E.J., Simmons, M.J., and Snustad, D.P., 1991. Principles of Genetics (8th edition) John Wiley and Sons, Inc.
3. Jain, H.K., 1998. Genetics, Principles and Implications. Oxford and IBH Publishing Co. India.
4. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., and Watson, J.D., 1994. Molecular Biology of the Cell. Garland Publishing Inc.
5. Verma, P.S. and Agarwal, V.K., 1989. Genetics. S. Chand and Company.
6. Goodenough, U., 1985. Genetics (4th edition). Holt Reinhart and Winston.
7. Strickberger, M.W., 1990. Genetics (3rd edition). Macmillan Publishing Company, New York.
8. Stent, G.S. and Calendar, 1978. Molecular Genetics. W.H. Freeman and Co., Sanfrancisco.
9. Ayala, F.J. and Kiger, Tr.J.A., 1980. Modern Genetics. The Benjamin/Cummings Publishing Company, Inc.
10. Winchester, A.M., 1977. Genetics (5th edition). Hongton Mifflin Company, Boston.
11. Lewin, B., 1997. GENES VI. Oxford University Press.
12. Watson, J.D., Hopkins, N.H., Roberts, J.W., Steitz, J.A., and Weiner, A.M., 1987. Molecular Biology of the Gene. Benjamin/Cummings, Menlo-Park, CA.
13. Kirpichnikov, 1981 Genetic Boses of Fish selection. Springer-Verlag, Berlin, Heidelberg. New york.
14. Purdam, C., 1992. Genetics and Fish Breeding. chapman and Hall.
15. Smartt, J. and Bundell, J.H. 1996. Goldfish Breeding and Genetics. T.F.H. Publications, Inc. USA.

Department of Fisheries Technology
Course Code: FTL 203

Course Title: Fisheries Microbiology-II

Theoretical: 3 Cr.

1. **Aquatic microorganisms:** Microorganisms of freshwater and marine environment. Factors effecting growth of aquatic microorganisms and their activities related to aquatic animals. Economic importance of aquatic microoganisms.
2. **Contamination and spoilage of fresh fish:** Microorganisms of cold, temperate and tropical regions. Sources of contamination, causes of spoilage, factors affecting kinds and rates of spoilage, evidence of spoilage, chemical changes caused by microorganisms in fish.
3. **Spoilage of fishery products:** Frozen fish, canned fish, cured fish, fermented fish and surimi based products.
4. **Effect of processing on microorganisms:** Effect of low and high temperature, curing and others processing methods.
5. **Food borne illness:** Chemical and biological intoxication and bacterial food poisoning and infection (Botulism, Staphylococcal intoxication, Salmonellosis, Shigellosis, *Clostridium perfringens* infection etc.)
6. **Food safety and quality control:** Microbiological quality of fishery products. Quality control and quality assurance. Microbiological standard and sanitation in fish processing industry. Definition and principles of HACCP. Application of HACCP in fish processing industry.

Department of Fisheries Technology
Course No: FTL 204

Course Title: Fisheries Microbiology-II

Practical: 1.5 Cr.

Students shall maintain a record of everything done in the practical and field sessions in a Practical NoteBook to be signed and checked by teacher (s) concerned.

1. Important terminology and guideline for exercise in the practical classroom.
2. Study of different types of microscopes (principles and operation).
3. Study of different sterilization techniques: Moist heat sterilization, dry heat sterilization, tyndallization, gaseous sterilization and filtration by membrane filter.
4. Study of culture media: Ingredients, types, and preparation of culture media.
5. Culture of microoganisms: Broth culture, pour plate culture, spread plate culture, streak plate culture, stab culture and shake culture.
5. Microscopic observation of bacteria: Gram's stain, spore stain, flagella stain, Ziehl-Neelsen' s stain, Hiss's methods and Albert's staining.
6. Isolation and identification of bacteria**:** Morphological, biochemical and serological study.
7. Quantitative estimation of bacteria: Consecutive decimal dilution method and most probable number method.
8. Field visits for sample collection from selected fish landing centers, fish markets and processing plants and bacteriological analysis and preparation of report.

Text books and reference:

1. Frazier, W. C. and Westhoff, D. C. 1990. Food Microbiology. 3rd edition. McGrow Hill Book Co., New York. London.

2. Nickerson, J. T. and Sinskey, A. J.. 1993. Microbiology of Food and food processing. Alsevier, New York, Oxford, Amsterdam
3. Ravindran, K. N., Nair, I. A., Perigreen, P. A. Paniker and Thomas, M.. 1985. Harvest and Post-harvest Technology of Fish. Society of Fisheries.

   Technologists, India.
4. Reinheimer, G. 1985. Aquatic Microbiology. John Wiley & Sons. New York, Brisbane, Toronto.
5. Ward, D. R. and C. R. Hackney. 1991. Microbiology of Marine Food Products. A AVI Book, Van Nostrand Reinhold, New York.
6. Collins, C. H. and Lyne, P. M., 1976. Microbiological Methods (4th ed.) Butterworths & Co. Ltd., London
7. Barrow, G. L. and Feltham, R. K. A. (Ed.) 1993. Cown and Steel's Manual for the Identification of Medical Bacteria, Cambridge University Press.
8. Miwa, K. and Low, Su Ji. 1992. Laboratory manual on analytical methods and procedures for fish and fish products (2nd ed.). Marine Fisheries Research Department, SEAFDEC, Singapore.
9. Marvin L. Speck (Ed.) 1984. Compendium of methods for the microbiological examination of foods. American Public Health Association. Washington, D. C

Department of Aquaculture

Course Code: AQC 207
Course Title: Live Food Culture
Theoretical: 2 Cr.

1. **Introduction:** Importance, present status, and prospect of live food in aquaculture.
2. **Types of live food organisms:** Study the identity and availability of locally available important species of phytoplankton, zooplankton, anelids, bacteria, fungus and yeast.
3. **Culture of Microalgae:** Freshwater and sea water media; Physico-chemical factors of culture media, sterilization and maintenance of culture media. Culture technique - batch culture, and continuous culture. Collection & processing
4. **Toxin producing microalgae:** Identification, nature and extent of toxicity; culture media and technique
5. **Culture of zooplankton:** Techniques of culture with particular emphasis on freshwater and marine zooplankton viz. Diaphanosoma, Brachions, Ceriodaphuia, Moina.
6. **Culture of brine shrimp (*Artemia*):** Decapsulation, hatching and culture techniques for *Artemia* in Lab condition and in salt ponds.
7. **Culture of other food organisms:** Oligochaete worms (*Tubifex)* nematodes (Trochophora larvae), earthworms, frog tadpoles.
8. **Culture of microorganisms:** Preparation of media, isolation and culture techniques of important friendly bacteria yeast and fungus
9. Proximate composition, preservation and storage of fish food organisms.
10. Economic importance of live food culture.

Text and reference books:

1. Fulks, W and Main, K. L. (eds) (1992). Rotifer and microalgae culture systems. Argent Laboratory Press. 364 pp.
2. Lavens and Sorgeloos (eds). 1996. Manual on the production and use of live food for Aquaculture. 295 pp.
3. Stottrup (2002). Live feed for fish. 336 pp. (in press).

4. Barnalee, G. (1980). Rotifers: biology and rearing technology. In: Barnabe, G. (ed). Aquaculture Vol. 1, ELLIS Harwood Publications, London, England.
5. Bhat, B. V. (1995). *Artemia*. In: Live feed. Hand book on Aquaculture. The Marine Products Export Development Authority (Ministry of Commerce, Government of India) Kochi, India.
6. Gilbert, J. J., Lubzens, E. and Miracle, M. R. (1991). Rotifer Symposium VI. to Proceedings of the sixth international Rotifer symposium, Banyoles, spain, June 3-8, 1991. 572 pp.
7. Fogg, G. E. (1996) Algal culture and phytoplankton ecology. University of Wiscon (In press.)
8. Omori, M. and T. Ikeda, (1984). Methods in Marine Zooplankton Ecology. John Willy & Sons, UK. 332 pp.
9. Simpson, K. L., Klein-mcPhee, G. & Beck. A. D. (1982). Zooplankton as food source. Proc. 2nd Conf. on Aquaculture Nutrition. Biochem. and Physiol. Approches tio shellfish Nutrition. Rohoboth Beach, Delaware/USA; October, 180-201.
10. Verreth, J. (1999). Fish Larval Nutrition. Chapman & Hall. 256 pp.
11. Vymazal, J. (1995). Algae and demenl cyclying in wetlands. CRC prees, Inc. Boca Raton, USA. 689 pp.
12. Phang, S. M. and Chu, W. L. (1999). University of Malaya Algae Culture Collection (UMACC). Catalogue of strains. Institute of Post graduate studies & Research, University of Malaya, Kuala Lumpur, Malaysia. 77 pp.
13. Yamagishi, T. (1992). Plankton algae inTaiwan (Formoza). Uchida Rokakuho, Tokyo, Japan. 252 pp.
14. Mamaril, S. A. C. and Fernando, C. H. (1978). Freshwater Zooplankton of the Philippines (Rotifera, Cladocera and Copepoda). Natural & Applied Science Bullectin. 30(4): 109-221.
15. Wiessner, W., Schnepf, E., Starr, R. C. (1995). Algae, Environment and Human affairs. Biopres limited, Bristol, London, UK. 258 pp.

Department of Fisheries Management

Course Code: FMG 205
Course Title: Aquatic Environment and Toxicology
Credits hour: 2 Cr.

1. **Introduction on aquatic environment:** Key concepts; Importance of aquatic environmental maintenance; Sensitivity of aquatic biota on environmental changes:
2. **Aquatic pollution:** Types of pollution. Sources and their impacts on aquatic plants, aquatic animals and human beings. Aquatic toxicity. Factors influencing toxicity. Toxicity testing. Prevention and control measures.
3. **Industrial and Agricultural pollution:** Sources and types of industrial and agricultural pollution. Major polluting industries. Pollution due to intensification of agriculture. Toxic effects of pollutants from tanneries, textiles and chemical industries on fresh water and marine waters. Impacts of agricultural pollution on aquatic animal and human health.
4. **Impact of aqua farming on aquatic environment:** Nutrient accumulation and Eutrophication, drainage effect due to excess feed, fertilizer and therapeutants. Loss of natural habitats, mangroves, agricultural lands, livestock pastures etc.
5. **Heavy metals:** Lethal and sub-lethal effects of heavy metals on aquatic biota; Effects on domestic animals and public health.
6. **Algal toxins:** Implications on aquatic food webs; Mode of action of toxins in seafood poisoning; paralytic shell fish poisoning (PSP),diarrhetic shellfish poisoning (DSP), ciguatera fish poisoning (CFP), *Pfiesteria* toxin and domoic acid. Measurement of toxins from different groups of toxic algae. Economic and social effects of algal toxin and control strategy.

Text books and references:

1. Alabaster, J.S. and Lloyd, R., 1982. Water Quality Criteria for Freshwater Fish. Second Edition. Butterfly Scientific Publisher, London.
2. Ali, M.Y., 1991. Towards sustainable development: Fisheries resources of Bangladesh. IUCN, NCS and BARC. 96 pp.
3. Baird, D.J., Beveridge, M.C.M., Kelly, L.A. and Muir, J.F. (eds.), 1994. Aquaculture and Water Resource Management. Fishing News Books, UK. 219 pp.

4. Boyd, C. E., 1988. Water Quality Management for Pond Fish Culture. Elsevier Scientific Publisher B. V., Amsterdam. 318 pp.

5. Flood Action Plan (FAP)-17, 1994. Fisheries Studies and Pilot Project, Final Report, GOB and ODA (UK).
6. Furness, R.W. and Rainbow, P.S. (eds.), 1990. Heavy Metal in the Marine Environment. CRC Press, Inc., Florida. 256 pp.
7. Furness, R.W. and Rainbow, P.S. (eds.), 1993. Ecotoxicology of Metals in Invertebrates. Lewis Publishers, Florida. 461 pp.

8. Haslam, S.M., 1991. River Pollution: An Ecological Perspective. CBS Publishers & Distributors (Pvt.) Ltd.
9. Islam, M.A., 1994. Toxic Chemicals and Hazardous Wastes: Bangladesh Context. Department of Environment, Dhaka. 96 pp.

10. Lloyd, R., 1992. Pollution and Freshwater Fish. Fishing News Books, Oxford, UD. 176 pp.
11. Moriarty, F., 1993. Ecotoxicology: The Study of Pollutants in Ecosystems. Academic Press, London. 289 pp.

12. Muller, R. and Lloyd, R., 1994. Sublethal and chronic effects of pollution on freshwater fish. Fishing News Books, UK. 288 pp.

13. Penman, D., 1994. Coastal environmental Management for Sustainable Aquaculture Workshop Proceedings of AADCP Component I, held in Bali, Indonesia, 31 October, November, 1994. AADCP/PROC/7. 221 pp.

14. Rahman, A.K.A., 1989. Freshwater Fishes of Bangladesh. Zoological Society of Bangladesh, Dhaka. 364 pp.
15. United Nations Environment Program, 1992. Chemical Pollution: A global review. A joint publication of the International Register of Potentially Toxic Chemicals and the Global Environment Monitoring System's Monitoring and Assessment Centre. UNEP, Nairobi, Kenya. 106 pp.
16. Vymazal, J., 1995. Algae and Element Cycling in Wetlands. CRC Press, Inc., Florida. 689 pp.