

**Syllabus  
for  
Master of Science in Marine Science  
Department of Fisheries and Marine Science  
Noakhali Science and Technology University**

**First Year, First Term**

Course No.	Course Title	Credit Hours
MAR 5101	Marine Biology	3.0
MAR 5103	Meteorology and Climate Science	3.0
MAR 5105	Marine Chemistry	3.0
MAR 5107	Marine Resources and Exploitation	3.0
MAR 5109	Application of Statistics in Marine Science	3.0

**First Year, Second Term**

Course No.	Course Title	Credit Hours
MAR 5201	Physical Oceanography and Hydrography	3.0
MAR 5203	Maine Geology and Bathymetry	3.0
MAR 5205	Marine Pollution and Environmental Assessment	3.0
MAR 5207	Maritime Navigation and Law of the Sea	3.0
MAR 5209	Marine Remote sensing and GIS	3.0

**Second Year, First Term**

		Credit Hours
MAR 6102	Thesis	10.0
MAR 6104	Seminar on Thesis	1.0
MAR 6106	Viva-voce	2.0

## First Year, First Term

### MAR 5101 Marine Biology

3.0

1. Introduction, history, origin and evolution of life, zonation of the oceans.
2. Marine and coastal environment–biological zonation, inter -tidal ecosystem (rocky-zonation pattern physical and biological factors, sandy shores and protected sand flats-physical and biological factors, faunal composition and adaptations), sea as a biological environment.
3. Phytoplankton systematics, diatoms and dinoflagellates, phytoplankton of Bangladesh, primary production, primary productivity and its measurement, factor affecting primary productivity.
4. Zooplankton systematic, mero and holoplankton, zooplankton of Bangladesh, ecology of zooplankton, secondary production.
5. Benthos systematic, infauna and epifauna, deep sea benthos, ecology and zonation of benthic communities.
6. Macroalgae and seagrass, classification and uses.
7. Mangroves, ecology, zonation and ecological roles.
9. Coral reefs, types, distribution and development.
10. Fisheries oceanography; Observable parameters, Fish diversity, fisheries ecology and ecosystems, scale of study, tools and techniques.
11. Food chain and food web in the sea.

#### Suggested readings:

1. Carol M Lalli & Timothy Parsons (1997) *Biological Oceanography: An Introduction*, 2nd edition. Butterworth-Heinemann Publishers. ISBN 0750633840.
2. Levinton, J. (2009) *Marine Biology: Function, Biodiversity, Ecology*. (3rd edition, Oxford University Press).
3. Sumich, James, L. & Morrissey, John, F. (2008) *Introduction to the Biology of Marine Life*, 9<sup>th</sup> edition. Jones & Bartlett Publishers. ISBN: 0-7637-3313-X.
4. M. Takahashi, B. Hargrave & T. R. Parsons (2005) *Biological Oceanographic Processes*, 344 pages, 3rd Edition. Pergamon Press.
5. Jumars, P. A. (1993) *Concepts in Biological Oceanography: An Interdisciplinary Primer*. Oxford University Press, New York. 348 p. ISBN 0- 19-506732-0.

### MAR 5103 Meteorology and Climate Science

3.0

1. Atmosphere, its structure and composition, air pressure and density.
2. Weather and Climate
3. Temperature and heat transfer; conduction, convection and radiation; absorption, emission and equilibrium; solar energy, seasonal variations
4. Air temperature: Diurnal, seasonal variations;
5. Atmospheric water: humidity, relative humidity, vapour pressure, condensation, dew, frost, fog, mist, cloud: classification of clouds
6. Atmospheric stability, precipitation, types of precipitation, the global hydrologic cycle.
7. Air pressure and air circulation: local winds, global atmospheric circulation
8. Air masses, and fronts
9. Thunderstorms and tornadoes
10. Cyclones: tropical and extra-tropical
11. Weather forecasting: weather information, data collection and equipment, forecasting tools and methods, types of forecast
12. Global and local climates; Maritime and continental climate; the Asian Monsoon; El-Nino Southern Oscillation; Indian Ocean Dipole; climate of Bangladesh
13. Climate change: causes and impacts of climate change; Global Warming, Carbon cycle, carbon emission and sequestration, Sea Level Rise; Arctic climate and sea ice; ice caps and permafrost; glaciers and world water resources; climate predictions.

### **Suggested Readings:**

1. *Essentials of Meteorology, 3rd Edition*. By C. Donald Ahrens.
2. *Meteorology Today: An Introduction to Weather, Climate and the Environment, 9th Edition*. By C. Donald Ahrens. Brooks/Cole, 2007.
3. *Atmosphere, Weather and Climate, 8th Edition*. By Roger Graham Barry & Richard J. Chorley. Routledge, 2003.

### **MAR 5105 Marine Chemistry**

**3.0**

1. Introduction, chemical composition of seawater, major and minor elements present in the sea water, factors affecting the distribution of trace elements in the sea, sources of salt, constancy of composition, the properties of water and seawater, artificial sea water.
2. Salinity and its measurement, global and vertical salinity distribution, density and vertical density profiles, temperature maximum density profile, thermohaline circulation.
3. Solubility of gases, dissolved gases, conservative and non-conservative gases, global and vertical distribution of dissolved gases.
4. The CO<sub>2</sub> system, carbonate chemistry, air-sea exchange, pH and CO<sub>2</sub>
5. Ocean acidification, causes, effects on fishes and invertebrates
6. Nutrients, redfield ratios, sources, forms, ranges and distribution of N, P and Si
7. Global Biogeochemical Cycles: The marine carbon cycle - long term cycles, weathering, preservation in sediments, anthropogenic impacts. The Nitrogen Cycle - denitrification, nitrogen fixation, anammox. The phosphorus and silicon cycles.
8. Introduction to stable isotopes and radiochemistry, chart of the nuclides, Applications. eg. Carbon-14 dating, particle scavenging rates, quantification.

### **Suggested Readings:**

- Emerson, S.R and Hedges, J.1. *Chemical Oceanography and the Marine Carbon Cycle*. Cambridge University Press, Cambridge, UK, 2008.
- Pilson, M.E.Q. *An Introduction to the Chemistry of the Sea*. Prentice Hall, New Jersey, USA, 1998.
- Sarmiento, J. and Gruber, N. *Ocean Biogeochemical Dynamics*. Princeton University Press, Princeton, N.J, USA, 2006.
- Berner. Elizabeth Kay and Robert A. Berner. *Global Environment: Water, Air, and Geochemical Cycles*. Prentice Hall, New Jersey, 1996.
- Broecker, Wallace and Peng, Tsung-hung, *Tracers in the Sea*, Palisades, N.Y. Lamont-Doherty Geological Observatory, Columbia University. 1982.
- Burdige David, *Geochemistry of Marine Sediments*. Princeton University Press, 2006.
- Morel, Francois M. M. and Janet G. Hering. *Principles and Applications of Aquatic Chemistry*. Wiley-Interscience, New York, 1993.
- Millero, Frank J. *Chemical Oceanography*, Third Edition. CRC Press, New York, 2006.
- Marine Biogeochemical Cycles, 2nd Edition* by Rachel James. The Open University, ISBN: 0750667931
- Seawater: Its Composition, Properties and Behavior, 2nd Edition* by The Open University, ISBN: 0750637153.
- Marine Biogeochemical Cycles* (second edition). Open University. ISBN075066791.
- Marine Geochemistry*. H.D. Schulz and M. Zabel (eds.). ISBN 354066453X

### **MAR 5107 Marine Resources and Exploitation**

**3.0**

1. Introduction, types of marine resources, exploration and exploitation
2. Classification of all invertebrate Phyla up to Class.

3. Protozoans, Sponges, Coral and coral reefs, Rotifers, polychaetes, Crustaceans, Gastropods, Pelecypods, Cephalopods, Aquatic Insects, Echinoderms.
4. Economic importance of each of the invertebrate phyla with special emphasis on fisheries.
5. Classification of the Phylum Chordate up to Order with special emphasis on the aquatic ones.
6. Protochordates and Hemichordates, Urochordata, Cephalochordata.
7. Amphibia, Reptilia, Aves, Mammalia, Pisces.
8. Economic importance of various groups of chordates with special reference to fisheries.
9. Marine protected areas, Overfishing, Endangered tropical coastal systems: coral, mangroves, seagrass. Endangered marine species. Marine therapeutics and biotechnology. Biodiversity in the coastal regions (St. Martin & Sundarban).
10. Hydrocarbons, fossil fuels (Oil and Gas).
11. Energy from the dynamic ocean: wave energy, tidal energy, wind energy and thermal energy. Possible ocean energy use in Bangladesh.
12. Polymetallic nodules, manganese nodules, different sands, mineral resources, placer deposits, phosphorite deposits, evaporite deposits, polymetallic sulphides, gas hydrate, marine aggregates etc.

### **Suggested readings**

- Jordan, E.L. and Verma, P.S. 2001. Invertebrate Zoology, S. Chand and Company. Ramnagar, New Delhi.
- Kotpal, R.L. 2007. Modern Text Book of Zoology, Invertebrate (Animal Biodiversity –II). Capital Offset Press, New Delhi, India.
- Robert, T. Orr. 1982. Vertebrate Biology. Saunders College Publishing.
- Young, J.Z. 1981. The Life of Vertebrates (3<sup>rd</sup> edition). Oxford University press.
- J. Levinton (2009) *Marine Biology: Function, Biodiversity, Ecology*. (3rd edition, Oxford University Press).
- Sumich, James, L & Morrissey, John, F. (2008) *Introduction to the Biology of Marine Life*, 9<sup>th</sup> edition. Jones & Bartlett Publishers. ISBN: 0-7637-3313-X.

### **MAR 5109 Application of statistics in Marine Science**

**3.0**

1. Introduction: Basics of statistics-sample, population, statistic etc
2. Sampling: types of sampling, sampling process, sample size, replication and pseudo replication, random sampling: simple random sampling, stratified random sampling, systematic sampling and their uses, sampling and non-sampling errors.
3. Presentation of data: Types of data, understanding data, levels of measurement, frequency distribution for nominal, ordinal, discrete and continuous scale data; understanding boxplots; error bars.
4. Measures of asymmetry, Probability, Normal distribution.
5. Descriptive statistics: Central Tendency (mean, mode, median), Measures of variability (range, variance, interquartile, standard deviation, standard error)
6. Measures of relationship: Coefficient of correlation, simple correlation, ranks correlation. Measures of association: Regression coefficient, simple regression, multiple regressions, Use of regression and correlation analysis
7. Hypothesis testing: Introduction: hypothesis, null hypothesis, alternative hypothesis, level of significance, confidence limit, error (Type I and Type II) and power.
8. Steps of hypothesis testing; parametric and nonparametric test; checking criteria for parametric test, choosing between parametric and nonparametric test, One tailed and two-tailed test. Data transformation.
9. Parametric tests: t-test,  $X^2$  test, conditions for applying  $X^2$  tests, uses of  $X^2$  tests, application of F tests, analysis of variance, techniques of analysis of variance, techniques of analysis of variance one way and two way classification models for ANOVA.

10. Non parametric tests: Introduction, advantage of non parametric tests, Mann-Whitney test, Spearman's rank Correlation, Kolmogorov-Smirnov sample test, Kruskal-wallis test, Wilcoxon signed Rank test.

### **Suggested readings**

Methods of statistics, by MG Mustafa  
Research methodology and statistical techniques, by S Gupta  
Statistical methods, by SP Gupta  
Statistics for management, by RI Levin and DS Rubin  
Designs and analysis of experiments, by DC Montgomery  
Fundamentals of bio-statistics (biometry), by S Prasad, 1992  
Statistical methods in biology, by Norman and Bailey, 1995  
Biometry, by RR Sokal and FJ Rohlf, 1981

### **First Year, Second Term**

#### **MAR 5201 Physical Oceanography and Hydrography**

**3.0**

1. Introduction and scope of physical oceanography, physical properties of sea water.
2. Salinity, density, distribution and implication, T-S diagram, relationship among salinity, temperature, depth and pressure.
3. Hydrostatic pressure, effects of pressure on salinity and temperature
4. Ocean temperature: Measurement, causes, vertical and horizontal distribution and Implication.
5. Light and sound propagation in the sea, acoustic properties, colour of sea water.
6. Colligative properties of the sea water, boiling points, freezing points, Heat and heat transfer, heat budget, convection and advection, diffusion and eddy diffusivity.
7. Currents: Causes, types, wind-driven circulation, Wind-driven gyres and their boundary currents, Ekman transport, current in Atlantic, Pacific and Indian Ocean.
8. Tide: Causes, types, and effects, global distribution, Implications, Tidal gauge, Chart datum.
9. Waves: origin, types, characteristics of wave, wave energy.
10. Sea level change, causes, past, present and future trends of Sea Level changes. Consequences of Sea Level changes.
11. Hydrography and charting:
  - 11.1 Parameters of interest in marine hydrography, tools & techniques, equipments & software
  - 11.2 Cartographic principles, bathymetric products and nautical charts, errors & uncertainty in ocean mapping, survey standards, output/product formats: paper based, & electronic
  - 11.3 Global and national organizations and initiatives for hydrography and charting
12. Ocean modeling

### **Suggested readings:**

1. The Ocean: Their Physics, Chemistry and Biology, 1962. Sverdrup, H.U., Johnson, M.W. and Flemming, R.H., Asia Publ. House, New Delhi
2. Rhatt, J.J., Oceanography, 13. Van Nostrand Company, New York.
3. King, C.A.M., Oceanography for Geographers, Edwin Arnold Publishers Ltd. London
4. Sharma, R C. and Vatal, M. Oceanography for Geographers, Chaitanya Publishing House, Allahabad, India.
5. Carson, R.J., The Sea Around, Staples Press Ltd. London.
6. Engel, L., The Sea, Time Incorporated, London.
7. Islam. M.S. Sea Level Changes in Bangladesh 2001

**MAR 5203 Marine Geology and Bathymetry****3.0**

1. Introduction and scope of geological oceanography, origin of ocean basins, Size and shape of the ocean basins: Pacific, Atlantic and Indian, Continental drift sea floor spreading and plate tectonics, Evolution of the Indian ocean
2. Morphology and structure of continental margins, mid oceanic ridges and deep sea floor
3. Relief of the Ocean: Physical feature of the ocean floor, ocean floor topography, trenches, oceanic ridges, submarine canyon, continental shelves & slope, ocean floor of the Atlantic, Pacific and Indian Ocean.
4. Marine Sediments: source of sediments, types, sizes, characteristics, Transportation process, depositional environments.
5. Sediment of the continental shelf and deep sea.
6. Sea level changes: Geological evidence and consequences: Eustatic vs. relative sea level changes: effects of sea level change on marginal marine environments.
7. Bathymetry, bathymetric data, sea floor mapping:
  - 3.1 Principles of sound propagation in sea water, its applications;
  - 3.2 Seismic and acoustical instruments: sound sources and receivers; Echo-sounder/SONAR, Fish Finder, Acoustic Doppler Current Profiler (ADCP)
  - 3.3 Acoustic data processing; bathymetric and seismic profiling; detection and assessment of oil and gas reserves, Mechanical bathythermograph, Expendable bathythermograph.

**Suggested readings:**

Marine Geology, 1982 James P. Kennet, Prentice Hall INC Englewood, Cliffs, N. J. 07632.  
Duxury, A.B. R Duxubury A.C (1999): Fundamentals of Oceanography (3rd Ed.), WCB/MC Graw-Hill.  
Thurman, H.V. (1994): Introductory Oceanography (7th Ed.), Macmillan Pube. Comp.  
Seibold, E. & Berger, W. H: The sea Floor- An Introduction to Marine Geology (3rd Ed.).  
Erickson & Timothy (2002): Marine Geology.  
The Ocean Basins: Their Structure and Evolution (second edition). Open University. ISBN 0750639830  
The Sea Floor An Introduction to Marine Geology (third edition). E. Seibold and W.H. Berger. ISBN 3540601910

**MAR 5205 Marine Pollution and Environmental Assessment****3.0**

1. Sources, types and mechanisms of water pollution
2. Water quality criteria for sea water
3. Effect of DDT, PCB's, Heavy metal (fish contamination, hair, feathers etc.) in marine organisms
4. Environmental effects of dredging, bottom trawling, offshore oil drilling and wind mill operation.
5. Environmental impacts of coastal and offshore aquaculture.
6. Toxicity tests LD50 LC50 Acute chronic exposure time's bioaccumulations, biomagnification
7. Detoxification mechanisms: 6.1 Mucus 6.2 Metallothioneins 6.3 Crystals
8. Oil pollution types: behavior of oil in the sewage and dumping activities in the sea and their effects (Toxic effects, ecological impact) on biota, control and removal of oil.
9. EIA, scope, role, process, applications, EIA of port establishment, hydropower projects.
10. Marine pollution conventions (Marpol)
11. Law of the sea to control marine pollution

**MAR 5207 Maritime Navigation and Law of the Sea****3.0**

1. Introduction to maritime navigation; importance of studying navigation
2. Tools and equipments necessary for safe navigation; modern engine ships and

different parts of a ship

3. Elements of navigation:

3.1 Navigational charts; their importance; essential features of a chart;

3.2 Position (dead reckoning, estimated position, fix), position fixing: classical and modern methods; marine GPS; bearing, course, track, back-track, and other essential terms/practices;

3.3 Sounding, sounding equipments, importance,

3.4 Communication methods, equipments and importance,

3.5 RADAR and its importance,

3.6 Coastal navigational aids/guides: buoys, floats, beacons, lights, etc.

4. Tide and current; their use in navigation; weather conditions at sea, and its significance in navigation; bad weather warnings and signals.

5. Navigational safety, and hazards; means of avoiding hazards.

6. Personal safety and precautions: fire, health hazards, lifesaving, distress, rescue; motion and sea sickness.

7. Management, administration, and discipline on a ship.

8. Navigating a small vessel/boat: essentials and methods.

9. Navigating in channels and rivers: essentials and methods.

10. Rules of the Road (ROR)

11. International and cross-sectoral Marine Affairs, Marine Management.

12. International Maritime Laws.

Suggested Readings:

1. Basic Marine Navigation, by Bart Jan Bok, Frances W. Wright. Houghton Mifflin.

## **MAR 5209 Marine remote sensing and GIS**

**3.0**

Remote Sensing

1. Introduction and scope of remote sensing

2. Sensor and satellite data

3. Satellite image processing

3.1 Data acquisition

3.2 Pre-processing: radiometric correction, geometric correction, enhancement

3.3 Feature extraction: ground truth survey, interpretation of key extraction, training area selection

3.4 Classification: visual interpretation, unsupervised and supervised classification

3.5 Post-processing

3.6 Output and maps

GIS

1. Introduction to GIS

1.1 General introduction and definitions

1.2 GIS requirements (hardware, software, manpower)

1.3 GIS and related technologies (Remote Sensing, GPS, Computerized Cartography, photogrammetry)

1.4 Applications of GIS

1.5 Future directions of GIS (WebGIS, OpenGIS)

2. Mapping and scales

2.1 Types of Maps

2.2 Map scale

2.3 Coordinates and projection systems

3. GIS data structure

3.1 Characteristics and sources of GIS data

3.2 Raster and vector data model: basic understanding

3.3 Understanding layers and attribute

4. Images and rasters/grids

- 4.1 Understanding rasters: raster properties – pixels, resolution, color depth, storage requirement and compression, histogram; advantages and disadvantages
- 4.2 GIS specific raster/grid manipulation: buffering, recalculation, reclassification, thinning, attribute manipulation, 3D modeling & analyses
- 4.3 Fundamentals of RS specific image manipulation
- 5. Vectors
- 5.1 Understanding vectors: topologies – point, line, polygon; storage requirement; advantages and disadvantages
- 5.2 Vector manipulation: overlay, buffer, geometric modeling
- 6. Attributes and database
- 6.1 Built-in attributes, raster and vector case, manipulating attributes
- 6.2 External data sources, manipulating external database, linking with GIS

#### Case Applications

- 1. Applications of GIS and RS in Marine and Coastal environments
- 1.1 Mangrove forest mapping and change detection
- 1.2 Resource classification - Zoning
- 1.3 Changes in coastline and bathymetry
- 1.4 Water quality mapping and modeling
- 1.5 Monitoring Sea Surface Temperature (SST)
- 1.6 Monitoring Oil Spills
- 1.7 Land use change detection
- 1.8 Biodiversity mapping

#### **Suggested readings**

- 1. Geographic Information Systems: an introduction, by J Star and J Estes. Prentice-Hall, NJ. 303pp. 1990.
- 2. An Introduction to geographical Information Systems, by I Heywood, S Cornelius and S Carver. Longman. 279pp. 1998.
- 3. The GIS Book (Third Edition), by GB Korte, P.E. Onward Press. 220pp. 1992.
- 4. Exploring Geographic Information Systems, by N Chrisman. John Wiley & Sons. 298pp. 1997.
- 5. Principles of Geographical Information Systems, by PA Burrough and RA McDonnell. Oxford University Press. 333pp. 1998.
- 6. Understanding GIS: The ARC/INFO Method (Third Edition). ESRI. 1995.
- 7. Datums and Map Projections for Remote Sensing, GIS and Surveying. By J Iliffe. Whittles Publishing. 150pp. 2000.
- 8. Remote Sensing and Image Interpretation, 3rd Ed. by TM Lillesand and RW Kieber. John Willey & Sons. 1994
- 9. Use of high-resolution Satellite data for Coastal Fisheries. RSC Series No.5. Remote Sensing Center, FAO. 1991.
- 10. Remote Sensing: Models and methods for Image processing, 2nd Ed. by RA Schowengerdt. Academic Press. 1997.
- 11. Space Application for Sustainable Development. UN, 1997.
- 12. Remote Sensing Note, Japan Association of Remote Sensing