Department of Oceanography

Faculty of Science
Noakhali Science and Technology University
Noakhali 3814, Bangladesh

Background

The ocean defines our planet and is essential for life on Earth. Yet it remains one of the last and least explored territories on the globe. For this reason, the Department of Oceanography at Noakhali Science and Technology University is committed to studying all aspects of the ocean as well as its intricate relationships with the Earth's atmosphere, land, ice, and life - including humans. This is crucial not just for advancing knowledge about our planet, but also for ensuring the long-term welfare of society and guiding environmental care. The faculty and researchers at this institution are committed to ocean science, ocean resources, and ocean environment. The objective is to provide information for public policy and decision making, as well as to increase public knowledge of the significance of the sovereign maritime, regional, and global ocean and its resources.

Vision and Mission

Through cutting-edge equipment, knowledgeable faculty and staff, an expanded frontier of research-based knowledge, and international standards supportive of the new horizons in a variety of fields, the university's vision is to promote and create a learning environment for higher maritime education with excellence.

The department is dedicated to providing quality education based on cutting-edge technical support in response to rising domestic and international concerns. The university is committed to fostering and developing world-class professionals who will serve humanity with a strong sense of ethical principles and competence, and who are prepared to compete in the maritime business, service, and employment sector.

Goals

- Through mutual cooperation with other similar universities/institutions, achieve the university's sustainable development and advancement.
- Continue modernizing educational services and facilities in response to the nation's needs and demands.
- Bring together all types of marine professionals to share knowledge and conduct research and development for the progress of the maritime industry.
- Enhance marine sector research consciousness in uncovering new perspectives in response to emerging issues.
- Accelerate the participation of alumni students and professionals in educational programs and the creation of projects aimed at expanding and enhancing academic standards.

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Syllabus for Master of Science in Oceanography

The master program has two tracts: (A) Master's by Thesis and (B) Master's by Project

A. Master's by Thesis

First Semester

Course code	Course title	Credit hours
OCN 5101	Satellite oceanography	3
OCN 5103	Meteorology, ocean dynamics and climate science	3
OCN 5105	Exploration of marine resources	3
OCN 5107	Marine geodesy and hydrography	3
OCN 5109	Marine affairs, governance and marine spatial planning	3
	Total credits	**15**

Second Semester

Course code	Course title	Credit hours
OCN 5201	Oceanographic and climatic data analysis	3
OCN 5203	Advanced Marine Biotechnology	3
OCN 5205	Scientific communication and proposal writing	3
OCN 5206	Seminar	1
	Total credits	**10**

Third Semester

Course code	Course title	Credit hours
OCN 5310	Thesis	18
	Total credits	**18**

B. Master's by Project

First Semester

Course code	Course title	Credit hours
OCN 5101	Satellite oceanography	3
OCN 5103	Meteorology, ocean dynamics and climate science	3
OCN 5105	Exploration of marine resources	3
OCN 5107	Marine geodesy and hydrography	3
OCN 5109	Marine affairs, governance and marine spatial planning	3
	Total credits	**15**

Second Semester

Course code	Course title	Credit hours
OCN 5201	Oceanographic and climatic data analysis	3
OCN 5203	Advanced Marine Biotechnology	3
OCN 5205	Scientific communication and proposal writing	3
OCN 5206	Seminar	1
OCN 5210	Project report	3
OCN 5202	Viva Voce	2
	Total credits	**15**

OCN 5101 **Satellite Oceanography** **Credit: 3**

Scope and objectives:
This course contains the basic concept of remote sensing. There is scope to learn the pre-processing and survey and training area selection. The visual interpretation, unsupervised and supervised classification are discussed in this course.

Learning and Outcomes:
After having this course students will learn about map reading, output, water quality mapping, modeling, and monitoring sea surface temperature, and oil spills. The students will learn about biodiversity mapping. The students will require introductory GIS knowledge. GIS data structure and GIS-specific raster/grid manipulation will also learn by students.

Course Contents:

1. Satellites and sensors: The basic principles of space technology; The basic elements and sampling characteristics of satellite orbits, Electromagnetic spectrum and satellite sensors, Active and passive sensors, Data transmission to the Earth, Orbit determination techniques.

2. Remote sensing of the sea: The general principles of remote sensing of the sea, Sensor calibration, Atmospheric correction, Positional registration, Oceanographic sampling for sea truth, Image processing, The main types of sensors: Visible wavelength – ocean color sensors, Infrared radiometers of sea surface temperature, Passive microwave radiometers, Active radar-altimeters of sea surface topography, Active microwave sensors of sea surface roughness.

3. Oceanographic Applications

   3.1 Infrared Measurement of Sea Surface Temperature: Infrared radiometry, Interpretation of sea surface temperature, Advanced Very High-Resolution Radiometer (AVHRR), Multi-Channel Sea Surface Temperature (MCSST) algorithm, Geostationary Operational Environmental Satellites (GOES), Coast Watch Sea surface temperature data source and software.
   3.2 Radar-altimeters: Basic principles of satellite altimetry, TOPEX/Poseidon satellite, Sea Surface Height: Geoid, Tides, Geostrophic circulation, Sea Surface Roughness: Microwave scatter meter, Synthetic Aperture Radar.
   3.3 Ocean Color: Basic principles of satellite measurements of ocean color, Coastal Zone Color Scanner (CZCS), Sea-viewing Wide Field-of-view Sensor (SeaWiFS), MODerate resolution Imaging Spectroradiometer (MODIS); Patterns of phytoplankton distribution in the World Ocean.

4. Ocean Color and Phytoplankton: Chlorophyll and photosynthesis, Vertical distribution of phytoplankton in the ocean, Estimation of phytoplankton biomass from satellite ocean color observations, Estimation of chlorophyll fluorescence from MODIS ocean color

observations, Coccolithophores and harmful algal blooms, Seasonal cycles of phytoplankton biomass, Global phytoplankton biomass and primary production.

5. Advanced Concept of Geo-information Science: Time Series Analysis, Network Analysis, Terrain Analysis, Process Modeling, Data Quality and Accuracy Assessment, Concept and Application of Geo-health, Customization, Scripting and programming, Geo-database, spatial database, Metadata, Model builder.

6. Coastal Erosion and Accretion: Time series analysis of coastal areas, sediment deposition, Island management.

Suggested literature/books:

1. Measuring the Oceans from Space: The principles and methods of satellite oceanography (Springer Praxis Books / Geophysical Sciences) by Ian S. Robinson.
2. Methods of Satellite Oceanography by Robert H. Stewart.
3. Satellites, Oceanography and Society, By D. Halpern,
4. Regional Satellite Oceanography by Serge Victorov.

OCN 5103 Meteorology, Ocean Dynamics and Climate Science 3 Credits

Scope and Objectives:
The course is designed to provide an exclusive understanding of Earth's climate and climate change, its economics, legal aspects, relation to sea level, consequences and mitigation strategies, ocean climate service as well as different climatic phenomena including ocean acidification.

Learning Outcomes:
Having completed this course, the students will a general understanding of the Earth's climate and ocean climate interaction as well as different climatic phenomena.

Course Contents:

1. Overview, structure and composition of the climate system.
2. Heat budget, Air-Sea interaction, Ocean circulation.
3. Atmospheric stability, precipitation, global atmospheric circulation.
4. Atmospheric wave motions, Rossby Waves, Acoustic Waves, Kelvin Waves, Gravity Waves; Atmospheric turbulence, barotropic and baroclinic instabilities.
5. Thunderstorms, Tornadoes and Cyclones: tropical and extra-tropical.
6. Global and local climates, the Asian Monsoon, ENSO, Indian Ocean Dipole and the climate of Bangladesh.

7. Climate variation during the postglacial period and assessment for future decades.
8. Current understanding of key climate issues, Natural causes of climate change and anthropogenic effects on climate.
9. Impact of climate change on estuarine, coastal and marine waters.
10. Physical, Chemical and Biological changes on ocean temperature, salinity, density, MLD, CO_2, O_2, currents, waves, tides, nutrients, flora and fauna etcetera.
11. Climate change and Sea-level rise, Salinity intrusion, Ocean biogeochemistry, Marine fisheries, Cyclones and storm surge.
12. Ecosystem and ecological response to climate change.
13. Climatic Hazards in Coastal Bangladesh: Non-Structural and Structural Solutions.
14. International Participations: Agenda-20, UNFCC, IPCC, Kyoto Protocol, COP, CDM, Carbon Trade.
15. Policy, laws, international conventions and country program.

Global awareness and IPCC interpretations,
Kyoto protocol and other international conventions,
Responses to climate change on global, national and local levels,
National Climate change strategies and activities,
Institutional arrangements of climate change.

Suggested literature/books:

1. Asian Development Bank, (1994) Climate Change in Asia: Bangladesh Country Report; Published by ADB.
2. Atmosphere, Weather and Climate, 8th Edition. By Roger Graham Barry & Richard J. Chorley. Routledge, 2003.
3. S. Huq, Z. Karim M. Asaduzzaman and F. Mahtab (1999) Vulnerability Adaptation to Climate Changes for Bangladesh, Kluwerr Academic Pub.
4. The Oceans and Climate, 2nd edition. By Grant R. Bigg. Cambridge University Press. 2003.
5. Paul, B. K., & Rashid, H. (2016). Climatic Hazards in Coastal Bangladesh: Non-Structural and Structural Solutions.

OCN 5105 **Exploration of marine resources** **Credit: 3**

Scope and Objectives:

This course deals with different forms of fossil fuel, their exploration, and renewable energy systems. Students will also know the definition and types of mineral resources of the sea and understand the mineral deposits and distribution in the ocean. They'll also learn about the origin, migration, and accumulation of petroleum.

Learning Outcomes:

Having completed this course, the students will get an overview of fossil fuels and renewable energy systems in light of climate change. The students will study different types of maps to identify resource distribution and offshore exploration.

Course Contents:

1. Introduction to marine resources, History of resources (natural) and civilization, Demand and use of marine resources, Sustainable development of marine resources.
2. Global overview of marine resources: occurrences, extraction and uses.
3. Types of marine resources

   3.1 Renewable:

   3.1.1 Non-living resources: Wave, Tide, Current, Wind, Thermal differences, Geothermal energy, Desalination.

   3.1.2 Living resources: Fishes, Shellfish, mollusks, crustaceans and other marine organisms (Examples include seaweeds, jellyfishes, sea urchins, sea turtles, seals, and even polychaete worms).

   3.2 Non-renewable: Gas, Petroleum, Minerals from sediment and water, Gas hydrates, Radio isotopes, Freshwater reservoir below seabed.
4. Exploration methods of renewable marine resources: Wind turbines, Wave & current energy extraction approaches and devices, Tidal barrages, Ocean Thermal Energy Conversion (OTEC), Desalination plant.
5. Exploration method of non-renewable marine resources

   5.1 Indirect method

   5.1.1 Marine 2D and 3D reflection seismic.
   5.1.2 Ocean Bottom Seismometer.
   5.1.3 Marine Magnetics.
   5.1.4 Marine Gravity.
   5.1.5 Heat flow Probe.
   5.1.6 Marine Electrical Resistivity

5.1.7 Marine Electromagnetics.

5.2 Direct method

5.2.1 Tools for seafloor imaging (HOMESIDE, Video sledge (STROMER), Side-scan Sonar.

5.2.2 Sampling devices (Piston corer and gravity corer, Multicorer, Box corer, Chain-bag dredge, TV-Grab, Vessel-Mounted (Surface) Drilling, Seabed (Subsea) Drilling.

6. Utilization of both renewable and non-renewable resources: Commercial/non-commercial, Industrial, Tourism/recreational.
7. Coastal and Marine resources of Bangladesh.

Suggested literature/books:

1. Renewable Energy Resources. Twidell, J.W. and Weir, A.D., English Language Book Society, London.
2. Mineral Resources. Flawn, P.T., John Wiley and Sons Inc.
3. Living Marine Resources. Iverson, E.S., Chapman and Hall.
4. Renewable Energy Technologies: Their Application in Developing Countries. Intermediate Technology Publications, London.
5. Petrology of the Ocean Floor. Hekinian, R., E.O. Series no. 33 Do.
6. Classic Mineral Localities of the World. Scalisi, P. and Cook, D., Van Nostrand Reinhold Company Inc., New York.
7. Industrial Utilization of Marine Non-living Resources. U.N., UNIDO, Madras, India.

OCN 5107 Marine geodesy and hydrography 3 Credits

Scope and Objectives:
This course contains earth's physical and geometric shape and to understanding hydrographic survey methods, hydrographic data collection and processing. There is opportunity to learn about projections, principles of cartography, positioning methods from this course. There is a scope about different processes of depth determination, seafloor classification and surveying.

Learning outcomes:
Students will study various hydrographic surveying techniques, data collecting, and processing. Students will also be taught coastal and offshore engineering methods.

Course Contents:

1. Definition, tasks, and importance of studying marine geodesy (MG) and Hydrography, MG data observation and hydrographic data gathering.

2. Satellite altimetry (mapping of the ocean surface).

3. Determination of positions for objects on the seafloor, in the sea, and on the sea surface.

4. Gravity field and the geoid in maritime regions.

5. Bathymetric survey and mapping of the seafloor.

6. Parameters of interest in marine hydrography, tools & techniques, equipment's & software.

7. Cartographic principles, bathymetric products and nautical charts, errors & uncertainty in ocean mapping, survey standards, output/product formats: paper based, & electronic.

8. Global and national organizations and initiatives for hydrography and charting.

9. Boundary demarcation and determination.

10. Ground truth: Calibration of navigation equipment and validation, Satellite altimetry, Internal navigation.

11. Registration of dynamic processes at the sea-bottom, including the prediction of natural disasters like seaquakes, tsunamis, etc.

12. Geodetic techniques for the study of seafloor deformation.

Suggested literature/books:

1. Segawa, J., Fujimoto, H., & Okubo, S. (Eds.). (2013). Gravity, Geoid and Marine Geodesy: International Symposium No. 117 Tokyo, Japan, September 30–October 5, 1996 (Vol. 117). Springer Science & Business Media.
2. Talley, L. D. (2011). Descriptive physical oceanography: an introduction. Academic press.

OCN 5109 **Marine affairs, governance and marine spatial planning** **Credit: 3**

Scope and objectives:
This course is intended to teach students the fundamentals of the marine affairs. It is possible to study several sorts of maritime territories and to learn about the functioning marine zones and legal implications of EEZ. The course will also cover the fundamentals of ocean governance, and marine spatial planning.

Learning outcomes:
After successfully completing this course, students will have a thorough understanding of marine territory. Students will be familiar with the many functions of BoB's maritime zones. The students will gather deep knowledge on marine affairs, governance and marine spatial planning.

Course contents:

1. General understanding of international maritime laws on rights, responsibilities, fishing, marine pollution, conservation, and safety; UN and other international bodies regulating maritime affairs: UNGA, IMO, FAO, WMO, IHO and UNCLOS.
2. Marine Pollution: Sources of Marine pollution; International treaties relating to marine pollution and its prevention: INTERVENTION 1969, London Convention/LC 1972, MARPOL 1973, 1978, 1997, FUND 1992, AFS 2001, International Convention for the Control and Management of Ships' Ballast Water and Sediments 2004, SENSREC 2009, OPRC 2016.
3. Marine Fisheries treaties: FAO Code of Conduct for Responsible Fisheries.
4. Marine conservation under the Law of the Sea convention; Conservation concepts: sanctuary, MPA, marine park, marine reserve, moratorium, etc., status of marine conservation in Bangladesh.
5. Maritime safety rules and regulations: SOLAS and COLREGs.
6. Principles of Maritime Delimitation; Bangladesh's maritime boundary disputes with India and Myanmar and their resolution.
7. Ocean governance and management, Ocean Policy: status in Bangladesh, Principles and Concepts of Sustainable Ocean Governance: Integrated Coastal Zone Management, Ecosystem Based Management and Zoning, Precautionary and Polluter Pays Principles.
8. Geo-politics of Bangladesh: Studies in Locational Significance.
9. Connectivity and Regional Trade, FTA agreement, ASEAN, BCIM, BIMSTEC, RECP, UNCLOS, Area Beyond National Jurisdiction (BBNJ, ABNJ), Indian Ocean Rim Association (IORA), One Belt One Road (OBOR) and Maritime Silk Route.
10. Unusual practices in the sea: Piracy, Human trafficking, Refugee movement etc.

11. Maritime defense and law enforcement: Navy and coastguards, Bangladesh Navy and Coast Guard: their roles and jurisdictions.

12. Vision 2041, Bangladesh Delta Plan 2100, Blue Economy and Sustainable Development Goals (SDGs).

13. Marine Spatial Planning (MSP) System as a tool for Sustainable Ocean Governance. MSP and Various Uses and Interests Relating to the Ocean Environment. MSP in Transboundary Context.

Suggested literature/books:

1. The Oceans: Key issues in marine affairs, by Hance D Smith (Ed), Springer-Science+Business Media. 2004.
2. Case studies in Oceanography and Marine affairs, by Garry Bearman (Ed), Pergamon Press. 1991.
3. Graham P. Chapman - Geopolitics of South Asia.
4. Harsh V. Pant and Kriti M. Shah - South Asia's changing geopolitical landscape.
5. Asanga Abeyagoonasekera - Geopolitics and Security: The view from South Asia Abbas. B.M. The Ganges Water Dispute.

OCN 5201 Oceanographic and climatic data analysis Credit: 3

Scope and objectives:
This course gives an introduction to statistical approaches typically used in oceanography and meteorology to analyze observed and simulated quantities. This covers descriptive statistics for quantifying the attributes of a data set and inferential statistics for testing hypotheses and drawing conclusions about unknown aspects of a population and their uncertainty. In addition, the course covers particular techniques for analyzing spatial data and time series, including empirical orthogonal functions, frequency analysis, and filtering. The theory will be used to solve geophysical issues.

Learning outcomes:
Students will be able to calculate and evaluate the fundamental statistical properties of a data set. In addition, they will comprehend the advantages and disadvantages of several methods of analysis usually applied to geophysical problems. In addition, they will be able to determine the frequency spectrum of a time series and apply the proper filters. In addition, they will be able to analyze enormous data sets using a cutting-edge programming language.

Course Contents:

1. Nature of oceanographic data, variables, data types and precision, geographic space and time space.
2. Sources of oceanographic data

   2.1 Field data collection, research vessels and ships of opportunity/VOS, fixed DCPs and buoys, moored array of probes, drifter, glider, floating and mobile platforms - tracers: e.g., Argo float.
   2.2 Shore based facility: e.g., Tide gauge, Radar.
   2.3 Bottom-mounted devices.
   2.4 Aerial and space-borne sensors.
   2.5 Acoustic survey and drilling.
   2.6 Derivatives of original data.

3. Archives and custodians of oceanographic and climatic data; data retrieval; Major data warehouses: WOD, WOCE, WOA, PODAC, DSDP, NODC/NOAA, SeaDataNet, Hadley Centre (UK), GLOSS, PSMSL, etc.
4. Data formats:

   4.1 ASCII and binary.
   4.2 ASCII: flat/sequential, delimited & CSV.
   4.3 Binary: raw/native, HDF, CDF/NetCDF, GRIB, image (e.g., tiff/geotiff, bil, img).
   4.4 Web format: XML.
   4.5 Archived: zip, tar, gz.
   4.6 Data dimensions: spatial and temporal.

5. Ancillary information: data quality; metadata; header/header file; data documentation.
6. Software and tools for oceanographic data manipulation and analyses:

   6.1 Generic tools: e.g., MATLAB, Octave, Freemat.
   6.2 Specialized tools: e.g., ODV, IDV, SeaDAS.
   6.3 Programming languages: e.g., Fortran/C, Python, MATLAB, IDL.
   6.4 Image Analysis software: e.g., Imagine, ENVI, ER-Mapper, MultiSpec.
   6.5 GIS software: e.g., ArcView/ArcGIS, Quantum, GRASS.
   6.6 FOSS vs Commercial.

7. Methods of data analyses; statistical methods; geospatial methods, modeling techniques, etc.
8. Hands on/case study:

   8.1 Harmonic analysis of tide, other tidal data analyses
   8.2 Seasonal change in Sea Surface Temperature, Chlorophyll

8.3 Wind stress and current
8.4 Tropical cyclone

Suggested literature/books:

1. Data Analysis Methods in Physical Oceanography, 2nd Edition. By William J. Emery & Richard E. Thomson. Elsevier Science, 2004.
2. Accessing data warehouse: downloading and opening data.
3. Using ODV: loading dataset, viewing and creating charts, making oceanographic inferences.
4. Scripting in Freemat/Octave/MATLAB: Variables and operators, arrays and matrices, array operations, control structures, plotting data, reading and writing files.
5. Mapping oceanic and climatic features using Quantum GIS.

OCN 5203 Advanced Marine Biotechnology Credit: 3

Scope and Objectives:
The Advanced Marine Biotechnology course includes the study of the genetic structure of marine organisms and the branches and scope of biotechnology. This course provides knowledge about biosensors and application and wastewater treatment.

Learning Outcome:
Students will learn about recombinant DNA technology and its application. They will gather the concept of transgenic fishes. The role of biotechnology in pollution control will learn by students.

Course Contents:

1. Genetic constitution of a population: Hardy-Weinberg equilibrium; factors altering gene and genotype frequencies. Genetic variation within a subdivided population: Quantitative measures of differentiation. Genetic distance.

2. Interpreting genetic variation detected by electrophoresis: Basic principles; genotypic data from electrophoresis; strengths and limitations of electrophoretic data for studying protein loci.

3. Natural hybridization and gene introgression in fishes: methods of detection; genetic interpretation of hybridized population.

4. Use of genetic markers in stock composition analysis: general principles and applications. Molecular Markers:

    Restriction fragment length polymorphism (RFLP)

Amplified fragment length polymorphism (AFLP)
Random amplified polymorphic DNA (RAPD)
Mini and microsatellite VNTRs
Roles of molecular markers in fisheries and aquaculture.

5. DNA fingerprinting: Multilocus DNA fingerprinting. Applications of DNA fingerprinting: Genome mapping, Gynogenesis, Aquaculture genetics and fisheries.
6. Mitochondrial DNA and analysis of fish population structures: The mitochondrial genome, restriction endonuclease analysis of mitochondrial DNA, genetic variation in stocks, applications of mitochondrial DNA variability.
7. Genetic drift: Finite population size and genetic drift. The effect of genetic drift. The founder effects and bottlenecks. Effective population size: separate sexes, variation in number of gametes, inbreeding, variation in time, age structure, neighborhood size. Genetic aspects of endangered populations.
8. Stock transfer relative to natural organization, management and conservation of fish population. Genetical conservation of exploited fishes.
9. Marine Biogeochemical Cycle, Geotracers.
10. Environmental Application of Marine Biotechnology: Natural filters, Bioremediation, Environmental restoration, Ocean Geritol effect, renewable fuels.
11. Green Biotechnology.
12. Blue Biotechnology.
13. Bioinformatics: BLASAT, Application of Bioinformatics.
14. Bioactive Compound: Opportunities and Challenges.
15. Biofouling: Antifouling Compounds.

Suggested literature/books:

1. Ryman, N. and Utter, F (editors) 1987. Population Genetics and Fishery Management. Washington Sea Grant Program, University of Washington Press, Seattle and London.
2. Falconer, D.S. and Mackay, T.F.C., 1996. Introduction to Quantitative Genetics (4th Edition) Longman, UK.
3. Crow, J.F. and Kimura, M., 1970. An Introduction to Population Genetics Theory. Harper and Row Publishers, New York.
4. Chapman, B. (Editor), 1985. General and Quantitative Genetics. Elsevier Science Publishers, B.V. Amsterdam-Oxford-New York-Tokyo.

5. Hartl, D.L. and Clark, A.G., 1989. Principles of Population Genetics (2nd edition). Sinauer Associates, Sunderland, MA.
6. Hedrick, P.W., 1985. Genetics of Populations. Jones and Bartlett Publishers, Inc. Boston.
7. Kirby, L.T., 1990. DNA Fingerprinting: An Introduction. W.H. Freeman and Co. Saltlake City, UT.
8. Mayden, R.L. (Editor), 1993. Systematics, Historical Ecology, and North American Freshwater Fishes. Stanford University Press, Stanford, USA.
9. Mustafa, G. 1999. Genetics in Sustainable Fisheries Management. Blackwell Science Ltd.
10. Roberts, D.F. and De Stefano, G.F. (Editor), 1986. Genetic Variation and its Maintenance. Cambridge University Press.
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 Focusing Techniques in Fisheries Management. CRC Press.
14. Ryman, N. and Utter, F (editors) 1987. Population Genetics and Fishery Management. Washington Sea Grant Program, University of Washington Press, Seattle and London.
15. Falconer, D.S. and Mackay, T.F.C., 1996. Introduction to Quantitative Genetics (4th Edition) Longman, UK.

OCN 5205 Scientific communication and proposal writing Credit: 3

Scope and Objectives:
The objective of this course is to provide students with an overview of performing scientific research. It examines the research process, the selection and definition of a research problem, the design of a research plan, sampling strategies, and methodology, data collection, the accuracy of results, the qualities of good research, the presentation of research findings, and research extension processes, as well as research issues in Bangladesh.

Learning Outcomes:
After having the course, the students will develop the capabilities required to conduct scientific research and presentation research outputs.

Course Contents:

1. Basics of scientific research.
2. Formulation of research hypothesis or research questions.
3. Experimental design, sampling strategies, data collection and development of laboratory protocols.
4. Data processing, data analysis, graphical representation, statistical & ecological analyses, data tabulation, use of different statistical models and accuracy of results.

5. Manuscript preparation (thesis/dissertation/article).
6. Writing techniques for research proposal.
7. Scientific communication skills (seminar, symposium, workshop, training program, popular and scientific paper publication).

Suggested literature/books:

1. Kothari, C.R., 2004. Research methodology: Methods and techniques. New Age International. pp. 418.
2. Lakatos, I., 1968, January. Criticism and the methodology of scientific research programs. In Proceedings of the Aristotelian society (Vol. 69, pp. 149-186). Aristotelian Society, Wiley.
3. Singh, Y.K., 2006. Fundamental of research methodology and statistics. New Age International.

OCN 5206 **Seminar** **Credit: 1**

Students give seminar presentation on current research in various fields of oceanography. Each student has to give presentations on a subject, selected by the department, related to his/her MS thesis/project.