



**Department of Oceanography
University of Dhaka**

**Curriculum of Courses
for
Master of Science (MS) in Oceanography**

Session: 2018-2019 to 2022-2023

Curriculum of Courses for Master of Science (MS) in Oceanography

In recent years, Bangladesh Government has taken strategic steps for Blue Economy, a sector which was relatively untapped and underutilized until now, could be an effective tool for substantial future economic growth. The Blue Economy approach could significantly contribute towards eradication of poverty, food security, generation of sustainable and inclusive livelihoods, mitigation & adaptation to climate change. Blue Economy requires a balanced approach between conservation, development and utilization of marine and coastal ecosystems, oceanic resources and services with a view to enhance their value and generate decent employment, secure productive marine economy and healthy marine ecosystems.

The Department of Oceanography at the University of Dhaka, up until now, the only one of its kind in Bangladesh, aims to advance our knowledge of all facets of the ocean environment around Bangladesh. Emphasis will be given to the physical, chemical, biological, geological and atmospheric aspects of the Indian Ocean especially the Bay of Bengal.

Department of Oceanography's goal is to advance marine sciences through observation, experimentation and modeling, and to provide excellent educational and research opportunities for graduate and undergraduate students in Bangladesh with degrees in Oceanography. Through active learning, research and discovery, we prepare students for careers across the public and private sector. The Master of Science in Oceanography degree program fosters a broad understanding of marine systems through an interdisciplinary program of study. The MS program has two tracks:

Thesis Group

The MS thesis group is a research-based program that emphasizes a hands-on approach to learning through the completion of an original thesis project under the direct mentorship of an experienced marine science researcher. The purpose of the thesis group is to give students the opportunity to develop a strong foundation in research methodology. Individualized programs of study ensure that each student has the best possible preparation based on their interests, background, and abilities. MS thesis students take core courses while engaging in an intensive, independent research project. Students work side-by-side with a faculty mentor to discover or synthesize knowledge that contributes to the field of marine science.

Project Group

The project group provides students with a broad-based, in-depth knowledge of physical, geological, chemical, and ecological processes in the ocean coupled with the technical skills necessary to contribute to the exploration of the marine environment and the management of its living resources. Because the project group is designed primarily for students seeking careers in applied resource management, this program emphasizes the practical skills and the analytical expertise required to monitor and manage the global ocean system.

PROGRAM OBJECTIVES

Students who successfully complete the Master of Science in Oceanography will:

1. Demonstrate an interdisciplinary knowledge of marine systems.
2. Demonstrate the ability to plan and implement observational, theoretical, and experimental studies.
3. Interpret and critique professional scientific literature.
4. Demonstrate an advanced ability to apply and integrate scientific principles and research data to address complex questions in marine systems.
5. Demonstrate competence in scientific communication through technical and scientific reports, publications and oral presentations.
6. Demonstrate professionalism and scientific ethics.
7. Have the competence to gain employment in advanced resource management positions or entrance to a doctoral program in related fields.

Masters in Oceanography will be offered and the degree will be in two streams which are as follows:

Masters by project work - **Project Group (A)**

Masters by research work - **Thesis Group (B)**

All courses are compulsory. Course No. OCN-501 to OCN-507 are compulsory for both project and thesis groups. Course No. OCN-508 to OCN-510 are for Project Group and Course No. OCN-511 & OCN-512 are for Thesis Group.

The Programme

The MS programme shall be of 30 credits and divided into 2 semesters. Each semester shall be of 19 weeks, of which 15 weeks will be for class teaching, 1 week break for preparation and 3 weeks for holding the semester final examinations

For a 3 or 4 credit theory courses there shall be three lecture classes per week i.e., a total of 45 lecture classes of 1 hour duration and for 2 credit course there shall be a two lecture classes per week i.e., a total of 30 lecture classes of 1 hour duration.

Note: Curriculum of courses and other rules (Credit and distribution of courses over the Semester, Evaluation and Grading, Degree Requirements, Credit Transfer, Improvement of Grades, Re-admission) are same as BS syllabus

Distribution of Courses

First Semester

<u>Course No.</u>	<u>Course Title</u>	<u>Credit Hours</u>
OCN-501:	Advanced Satellite Oceanography	3 Credits
OCN-502:	Ocean Dynamics and Climate Change	3 Credits
OCN-503:	Coastal and Marine Resources: Management and Policy	3 Credits
OCN-504:	Geopolitics of Indian Ocean Region	3 Credits
OCN-505:	Coastal Ecology and Management	3 Credits
OCN-506:	Numerical Models and Global Ocean Data Analysis	3 Credits
<hr/> Sub-total		18 Credits

Second Semester

<u>Course No.</u>	<u>Course Title</u>	<u>Credit Hours</u>
Project Group (A)		
OCN-507	Seminar in Oceanography	2 Credits
OCN-508	Lab. and Field Work	4 Credits
OCN-509	Project Report (Report-2; Presentation-2)	4 Credits
OCN-510	Viva-voce	2 Credits
<hr/> Sub-total (A) =		12 Credits
Thesis Group (B)		
OCN-507	Seminar in Oceanography	2 Credits
OCN-511	Thesis (Thesis-6; Thesis Presentation-2)	8 Credits
OCN-512	Viva-voce	2 Credits
<hr/> Sub-total (B) =		12 Credits
<hr/> Grand total (A+B) =		(18+12=30 Credits)

Detailed Syllabus

OCN-501 Advanced Satellite Oceanography

3 Credit

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.

GIS based Analysis: Spatial Analysis and Modeling (knowledge driven and data driven methods); Geo-statistical Analysis; 3-D Analysis; Interpolation; Topographic Analysis using TIN; DEM and Surfacing;

GIS Mapping: Elements and types of Map, Basics of Mapping, Concepts of mapping using RS and GIS;

Advanced Concepts and Principles of Remote Sensing: Air- and Space-borne

Multispectral and Hyperspectral remote sensing concepts: Sensors; Information Extraction Techniques, Pre-processing, Classification Approaches, Special Techniques used for Hyperspectral Imagery;

Radar and Lidar remote sensing: Concepts, Sensors; Information Extraction Techniques, Pre-processing, Classification Approaches, Special Techniques used for Radar imagery, Interferometry and Lidar & Radar Data Analysis;

Satellite born SAR (Synthetic Aperture Radar): Application of SAR, Radar Scatterometer and Radar Precipitation Sensors Onboard Satellites and their Applications.

Advanced Image Classification: Support Vector Machine, Super Resolution, Mapping, Markov Random Field, Sub-Pixel Analysis of Optical Imagery, Object-based image classification, Radar Image Analysis: Interferometry & Polarimetry,

Application of remote sensing in oceanography: Sea Surface Temperature, Sea Surface Level, Ocean Colour, Chlorophyll Content, Phytoplankton, Suspended Solid, Dissolved Organic Matter etc.

References:

John Stillwell, Graham Clarke - Applied GIS and Spatial Analysis

Jeremy W. Crampton (auth.), John Paul Jones (eds.) Mapping: A Critical Introduction to Cartography and GIS

John A. Richards, Xiuping Jia - Remote Sensing Digital Image Analysis: An Introduction

James B. Campbell PhD, Randolph H. Wynne - Introduction to Remote Sensing

Joe Breman, Charles Convis coordinator ESRI's Conservation Program - Marine geography-GIS for the oceans and seas

OCN-502: Ocean Dynamics and Climate Change

3 Credit

Overview of climate system

Climate variation during the postglacial period and to assess for future decades

Current understanding of key climate issues such as the working of the climate system

Natural causes of climate change and anthropogenic effects on climate

Impact of climate change on estuarine, coastal and marine water

Physical, Chemical and Biological changes on ocean temperature, salinity, density, MLD, CO₂, oxygen, ocean circulation, currents, waves, tides, nutrients, flora and fauna etc.

Impact of Climate change on ocean Biogeochemistry

Ecosystem and ecological response to climate change

Implication of climate change on estuarine, coastal and marine fisheries.

Sea level rise and salinity intrusion

Cyclone and storm surges

International Participations: Agenda-20, UNFCCC, IPCC, Kyoto Protocol, COP, CDM, Carbon Trade.

Policy, laws, international conventions and country program.

Global awareness and IPCC interpretations

Kyoto protocol and other international conventions

Responses to climate change: global, national and local

National Climate change strategies and activities

Institutional arrangements of climate change

References:

J.T. Houghton, G.J. Jenkins and J.J. Ephraums (1990) *Climate Change*, Cambridge University Press

S. Huq, Z. Karim M. Asaduzzaman and F. Mahtab (1999) *Vulnerability Adaptation to Climate Changes for Bangladesh*, Kluwer Academic Pub.

S.B. Smith (eds.) 1996 *Adapting to Climate Change: Assessment and Issues*, Springer.

Asian Development Bank, (1994) *Climate Change in Asia: Bangladesh Country Report*; Published by ADB.

Hug, S *et al* (1999) *Vulnerability and Adaptation to Climate Change for Bangladesh*, Kluwer Academic Publishers.

Washington W.M. and Parkinson C.L. (1986) *An Introduction to Three Dimensional Climate Modelling*, USA.

Lockwood, J. G. - *World Climatology: A Environmental Approach*. Edulard Arnold.

Climate change in Asia: Bangladesh - Asian Development Bank.

OCN-503: Coastal and Marine Resources: Management and Policy 3 Credit

Coastal and Marine Resources Management

Introduction to Natural Resources, History of Natural Resources and Civilization, Types of Natural Resources, Demand and Use of Natural Resources, Natural Resources Exploration, Economics of Natural Resources, Sustainable Development of Natural Resources. Environmental Impact of Natural Resources Extractions.

Global Overview of Natural Resources: Occurrences, Extractions and Uses, Legal Aspects and Policy of Natural Resources Management

Coastal and Marine Resources Management: Flora and Fauna, Coral Reef, Mineral Resources, Offshore hydrocarbon exploration and exploitation, Offshore mineral resources exploration and exploitation, Marine renewable energy resources.

Economics, Policy and Management of Natural Resources of Bangladesh:

- i) Energy Resources
- ii) Coastal and Marine Resources
- iii) Mineral/Other Resources
- iv) Fisheries Resources

Coastal and Marine Policy

Coastal Zone Management: Concept, Policies, ICZM, Land Reclamation, Coastal Zoning, Protection and Defense, Management techniques, Community Participation, Coastal Conservation

Bay of Bengal with emphasis on EEZ of Bangladesh and estuaries: Resource Utilization, Govt. policy on Bay of Bengal.

Marine and coastal community-based management

Marine and coastal ecosystem-based management

Marine protected areas

Marine debris

Maritime safety

Maritime security

Management of maritime cultural assets, Marine socioeconomics

Ocean Policy, Marine Fisheries Policy

Maritime Zones Act

MPA, ECA, ABNJ

References

- D. Raffaelli and S. (1997) Hawkins Intertidal Ecology
J. Pathick A. (1986) Introduction to Coastal Geomorphology
E.C. Birds (1993) Submerging Coast
S.C. Snedakar and J.G. Snedakar (1984) The Mangrove ecosystem

MS Islam (2001) *Sea-Level Changes of Bangladesh: Last Ten Thousand Years*
Mitchell, Bruce, *Geography and Resource Analysis*, London & New York: Longman
Simons, Ian., *The Ecology of Natural Resources*
Pierce, J.T., *The Flood Resource*
Islam, M.A., *Environment, Landuse and Natural Hazards in Bangladesh*
Kabir, M.H. and Amin, S.M.N. (2007) *Tanguar Haor: A Diversified Freshwater Wetland*,
Academic Press and Publishers Library, Dhaka.
Warrick and Ahmad (eds.) *The Implications of Climate and Sea Level for Bangladesh*

OCN-504: Geopolitics of Indian Ocean region

3 Credit

Geo-politics, Political Oceanography, Geo-economics and Geo-strategy: Conceptual Considerations

Geo-politics of Bangladesh: Studies in Locational Significance

Bangladesh in Asia: Relationship of Bangladesh with SAARC, ASEAN, China, India, USA, Europe and Middle-East/OIC Countries.

Geo-political Strengths and Weakness of Bangladesh

Indo-Bangladesh Relations: Geo-political, Geo-strategical and Geo-economic Considerations

Geo-political and Geo-strategical Aspects of Indo-Bangladesh Connectivity: Transit-Transshipment Problems, Asian Highway and Asian Railway, Port Facilities for Neighbouring Countries and Security of Bangladesh; Sub-Regional Groupings.

Hydro-Politics of Bangladesh: History, Farakka Problems, Transboundary River Disputes, Tipaimukh Dam and Interest of Lower Riparian Bangladesh, Teesta and Other Water-Sharing Problems of the Region.

Disputes of Bangladesh with Neighbouring Countries: Disputes Related to Demarcation of Boundary, South Talpatti Island and Demarcation of Maritime Boundary, Bangladesh-Myanmar Geo-political Problems (Maritime Boundary).

Security and Defense of Bangladesh: Classification of Security Strategies; Regional and International Cooperation; Environmental Politics and Security of Bangladesh; Maritime security; NGOs and Interference in National Security Issues.

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

References:

Graham P. Chapman - *Geopolitics of South Asia*

Marie Lall (Ed.) - *The Geopolitics of Energy in South Asia*

The China Pakistan Axis – Asia's New Geopolitics

Belt and Road -A Chinese World Order - Bruno Maçães

Bertil Lintner - *The Costliest Pearl: China's Struggle for India's Ocean*

Harsh V. Pant and Kriti M. Shah - South Asia's changing geopolitical landscape
Asanga Abeyagoonasekera - Geopolitics and Security: The view from South Asia
Abbas. B.M. The *Ganges* Water Dispute
Ahmad. M. (ed.) (1989) Flood in Bangladesh
Ahmed. Q.K. et al (eds.) (1994) Converting Water into Wealth
Gleick P.H. (ed.) (1993) Water in Crisis
Haggart K. (ed.) (1994) Rivers of Life
ICID (1994) Management of International River Basins and Environmental Challenges
Ohisson, L. (1995) Hydropolitics
Deniel, P. The Geography of Settlement
Jones, E. and Eyles, J. An Introduction to Social Geography, Oxford University Press, London.

OCN-505: Coastal Ecology and Management

3 Credit

The Chemical and Physical Environment: Measures of physiological performance; Temperature; Salinity; Oxygen; Light

Ecological and Evolutionary Principles of Marine Biology: Ecological interactions; Interactions on the scale of individuals; The population level; The community level: structure and interspecies interactions; The ecosystem level

Foraging; Predator-Prey and Trophic Interactions; Reproduction and Early Life History Patterns; Life History Traits and Social Behavior;

Distributions, Guilds, Habitat Utilization and Community Structure; Fish Communities in Estuarine and Marine Systems, Biology of reef fishes; Conservation and management

Reproduction, Dispersal, and Migration: Ecological and evolutionary factors in sex; Reproduction, demography, and life cycles; Migration; Larval dispersal at different scales

Physical Setting: Biology of reef invertebrates; Coral life history & reproduction; Coral reef trophic interactions

Reef Formation, zonation, biogeography, types, coral reef trophic system, Diversity and Distribution of Reef Organisms, Coral origins, evolution and speciation; Coral Reproduction, Larval Ecology, Coral diseases

Coral polyp; Symbiosis with zooxanthellae and calcification; Coral growth and reproduction; Factors limiting the growth; Distribution of coral reefs; Coral reef development and types;

Mangroves, sea grasses, sea weeds and algae

Zonation; Biological interactions in coral reef ecosystem; Bioerosion and corallivory. Bioerosion, competition, threats to coral reefs; Fieldtrip preparation and discussion of write-up; Fieldtrip to coastal areas of Bay of Bengal

References:

- Walker, P. & Wood, E. (2005) *The Coral Reef (Life in the Sea)*. ISBN 081605703
- Wolanski, E. (2000) *Oceanographic Processes of Coral Reefs: Physical and Biological Links in the Great Barrier Reef (1st Edition)*. ISBN 084930833
- Sorokin, Y. I. (1993): *Coral Reef Ecology (1st Edition)*. ISBN 9783540605324
- Bowen J. (2015) *The Coral Reef Era: From Discovery to Decline: A history of scientific investigation from 1600 to the Anthropocene Epoch (1st Edition)*. ISBN 9783319074788
- Wootton, R. J. (1992) *Fish Ecology (1st Edition)*. Springer Netherlands. ISBN 9780751403060
- Gerking, S. D. (1994) *Feeding Ecology of Fish (1st Edition)*. Academic Press. ISBN 9780122807800
- Pitcher, T.J., Morato, T., Hart, P. J. B., Clark, M. R., Haggan, N., Santos, R. S. (2007) *Seamounts Ecology Fisheries and Conservation*. Blackwell. ISBN 1405133430
- Ueda, H., Tsukamoto, K. (2013) *Physiology and Ecology of Fish Migration (1st edition)*. CRC Press. ISBN 9781466595132

OCN-506: Numerical Models and Global Ocean Data Analysis 3 Credit

Introduction to ocean modeling: Model analysis and optimization, filtering approximations. History and methodology of modeling the circulation of the world ocean.

The steady problem. A numerical approach to equatorial oceanic wave-mean flow interactions. Advective diffusion equation and turbulence

Small scale parameterization in large-scale ocean models. Finite difference technique, finite difference formulation of a world ocean model

One dimensional advective-diffusion models. Two dimensional models
Three dimensional circulation models, GFD Modular Ocean Model (MOM), S-coordinate models (SPEM/SCRUM), POM, ROMS, Miami Isopycnic Model. Worldwide ocean tide modeling

Open boundary conditions in numerical ocean models. Data and data processing, data analysis methods, Data assimilation. Mesoscale dynamics and dynamical forecasting

Scientific visualization: Using MATLAB to present scientific data

Students will access oceanographic data from local and global depositories: satellites, floats, and gliders. Students will manipulate, graph, and visualize data of increasing complexity while coding to visualize oceanographic events.

Introduction to instrument prototyping and measurements in environmental science. Hands-on with data collection: programming microcontrollers, interfacing hardware and software,

wireless sensor networks. Data analysis in Python. Problem solving with Matlab and C in the weekly computer laboratory.

References:

David M. Glover, William J. Jenkins, Scott C. Doney. Modeling methods for marine science.

Lakshmi H. Kantha, Carol Anne Clayson. Numerical models of ocean and oceanic processes

Advanced physical oceanographic numerical modeling,

James J. O'Brien, Henk A. Dijkstra. Dynamical Oceanography

Malek Madani. Physical Oceanography

Alfred R. Osborne. Nonlinear ocean waves

Richard E. Thomson, William J. Emery. Data analysis methods in physical oceanography

OCN-507: Seminar in Oceanography

2 Credit

Each student has to appear for two seminar presentations on current research in various fields of oceanography, selected by the department/course teacher, related to his/her MS thesis/project

OCN-508 Lab. and Field Work

4 Credit

Students will go for field work either in estuarine or coastal areas or in a cruise on ocean going vessel (ORV) in the offshore and deep sea area.