Syllabus for
B.Sc. (Hon's) in Oceanography

Department of Oceanography
Noakhali Science and Technology University
Noakhali-3814, Bangladesh

Courses in Brief

1st Year

First Semester	1st Year	
Course Code	**Course title**	**CH**
OCN 1101	Introduction to Oceanography	3
OCN 1103	Introduction to Earth Science	3
OCN 1105	Marine Ecology	3
OCN 1106	Marine Ecology Practical	1
OCN 1107	Marine Resources	3
OCN 1108	Marine Resources Practical	1
BLWS 1101	Bangladesh and Liberation War Studies	3
OCN 1102	Field Trip	1
	Total	**18**

Second Semester	1st Year	
Course Code	**Course title**	**CH**
OCN 1201	Atmospheric Science	3
OCN 1203	Marine invertebrates	3
OCN 1204	Marine invertebrates Practical	1
OCN 1205	Mathematics for Oceanographers	3
OCN 1207	Marine Vertebrates	3
OCN 1208	Marine Vertebrates Practical	1
ENG 1201	Communicative English	2
COMP 1201	Computer Application	3
COMP 1202	Computer Application Practical	1
OCN 1202	Viva Voce	2
	Total	**22**

2nd Year

First Semester	2nd Year	
Course Code	**Course title**	**CH**
OCN 2101	Physical Oceanography	3
OCN 2102	Physical Oceanography Practical	1
OCN 2103	Biological Oceanography	3
OCN 2104	Biological Oceanography Practical	1
OCN 2105	Coastal and Marine Aquaculture	3
OCN 2106	Coastal and Marine Aquaculture Practical	1
OCN 2107	Statistical techniques for Oceanographers	3
OCN 2108	Statistical techniques for Oceanographers practical	1
OCN 2109	Marine Environment and Climate Change	3
OCN 2110	Field Trip	1
	Total	**20**

Second Semester	2nd Year	
Course Code	**Course title**	**CH**
OCN 2201	Chemical Oceanography	3
OCN 2202	Chemical Oceanography Practical	1
OCN 2203	Marine Microbiology	3
OCN 2204	Marine Microbiology Practical	1
OCN 2205	Coastal Morphology and Estuarine Process	3
OCN 2206	Coastal Morphology and Estuarine Process Practical	1
OCN 2207	Oil, Gas and Renewable Energy	3
OCN 2209	Marine Biochemistry	3
OCN 2210	Marine Biochemistry Practical	1
OCN 2212	Viva Voce	2
	Total	**21**

3rd Year

First Semester	3rd Year	
Course Code	**Course title**	**CH**
OCN 3101	Geological Oceanography	3
OCN 3102	Geological Oceanography Practical	1
OCN 3103	Fisheries Oceanography	
OCN 3104	Fisheries Oceanography Practical	1
OCN 3105	Marine Plankton	3
OCN 3106	Marine Plankton Practical	1
OCN 3107	Law of the Sea	3
OCN 3109	Marine Pollution and EIA	3
OCN 3110	Marine Pollution and EIA practical	1
OCN 3112	Field Trip	1
	Total	**20**

Second Semester	3rd year	
Course Code	**Course title**	**CH**
OCN 3201	Hydrology and Fluid Dynamics	3
OCN 3203	Marine Biotechnology	3
OCN 3204	Marine Biotechnology Practical	1
OCN 3205	Remote Sensing and GIS	3
OCN 3206	Remote Sensing and GIS Practical	1
OCN 3207	Paleoceanography	3
OCN 3208	Paleoceanography Practical	1
OCN 3209	Oceanography of the Bay of Bengal	3
OCN 3202	Viva Voce	2
	Total	**20**

4th Year

First Semester	**4th Year**	
Course Code	**Course title**	**CH**
OCN 4101	Hydrography	3
OCN 4102	Hydrography Practical	1
OCN 4103	Marine Natural Products	3
OCN 4104	Marine Natural Products Practical	1
OCN 4105	Blue Economy and Sustainable Development	3
OCN 4107	Seamanship and Maritime Navigation	3
OCN 4108	Seamanship and Maritime Navigation Practical	1
OCN 4109	Ocean Forecasting and Meteorology	3
OCN 4110	Ocean Forecasting and Meteorology Practical	1
OCN 4111	Research Methodology	3
OCN 4112	Field Trip	1
	Total	**23**

Second Semester	**4th Year**	
Course Code	**Course title**	**CH**
OCN 4201	Port and Shipping Management	3
OCN 4203	Marine Biodiversity and Conservation	3
OCN 4205	Ocean Modelling	3
OCN 4206	Ocean Modelling Practical	1
OCN 4207	Integrated Coastal Zone Management	3
OCN 4209	Seafloor Exploration and Seismology	3
OCN 4211	Research Project	6
OCN 4202	Viva Voce	2
	Total	**24**

Courses in Detail

First Semester	1st Year	
Course Code	**Course title**	**CH**
OCN 1101	Introduction to Oceanography	3
OCN 1103	Introduction to Earth Science	3
OCN 1105	Marine Ecology	3
OCN 1106	Marine Ecology Practical	1
OCN 1107	Marine Resources	3
OCN 1108	Marine Resources Practical	1
BLWS 1101	Bangladesh and Liberation War Studies	3
OCN 1102	Field Trip	1
	Total	**18**

Second Semester	1st Year	
Course Code	**Course title**	**CH**
OCN 1201	Atmospheric Science	3
OCN 1203	Marine invertebrates	3
OCN 1204	Marine invertebrates Practical	1
OCN 1205	Mathematics for Oceanographers	3
OCN 1207	Marine Vertebrates	3
OCN 1208	Marine Vertebrates Practical	1
ENG 1201	Communicative English	2
COMP 1201	Computer Application	3
COMP 1202	Computer Application Practical	1
OCN 1202	Viva Voce	2
	Total	**22**

First Year
Semester I

OCN 1101	**Introduction to Oceanography**	**3 CH**

Scope and Objectives:
This course highlights the fundamental concepts of oceanography and introduces the ocean science to understand history of oceanography study physical, geological, biological, chemical and legal aspects of oceanography. The main objectives of this course are to understand the origin of ocean and changes trough time, the broad-scale features and dynamics of the Earth's oceans and to know about different aspects of world oceans.

Learning Outcomes:
Having successfully completed this curse, students will be able to collect and integrate information about ocean science. They will know the different branches of oceanography and the relationship between each other and finally they will introduce with the contemporary works and institutes of oceanography around the world.

Course Contents:

1. Introduction: Definition, nature, scope of oceanography and relationship with other subjects, Historical development of oceanography, Historical development of oceanography in Bangladesh
2. Branches of oceanography:
   Physical Oceanography: Salinity, conductivity, temperature, density, light and pressure, etc. of seawater, Waves: definition, classification and different types of waves, origin of surface waves, forms and characteristics, growth and dissipation of wind waves, breakers and surfs, Tides: definition, classification, causes and types of tide, storm surges, seiches, and Tsunami, Currents: definition, classification, causes and types of current, major surface current system of the World Ocean, atmospheric circulation, global wind pattern, Ekman spiral, Ekman transport and upwelling.
   Chemical Oceanography: water molecule, dissolving power of Seawater, composition of sea water
   Biological Oceanography: Plankton, Nekton, Benthos
   Geological Oceanography: Marine sediments, types of sediment based on sources and origins
3. Ocean Management

Recommended books:

1. Pickard, GL 1963. Description Physical Oceanography. Pergamon Press, London.
2. Yasso, WE 1965. Oceanography. Holt, Rinehert and Winston, Inc., New York.
3. King. CAN 1966. An Introduction to Oceanography. McGraw Hill Book Co, New York.
4. Pickard GL and WJ Emery, 4th enlarged, 1982. Descriptive Physical Oceanography. Pergamon Press, Oxford.
4. Weisberg, J and H Parish. 1974. Introduction to Oceanography. McGraw-Hill Kogakusha, Ltd., Tokyo.

OCN 1103 Introduction to Earth Science 3 CH

Scope and objectives:
This course discusses about the various aspects of earth science which are related to ocean. Origin, structure and evolution of the earth and oceans, and different earth processes are the major learning components in this course.

Learning outcomes:
Having successfully completed this course, the students will gather deep knowledge about various physiographic features of the earth. Students will have opportunity to learn different earth processes and various types of deposits in the deep sea.

Course Contents:
1. Origin and evolution of the Universe: Stars**,** Constellation Galaxies Sun Centered and Earth Centered Theories, Solar System

2. Origin and evolution of the Earth: Earth in Space, Earth as a Planet, Shape and Size, Geographic Grid, World Time Zone, The Geographical Time Scale etc. The hypsographic Curve: Configuration of the Earth Surface

3. Internal Structure of the Earth: Layers of Earth's Interior (based on chemical properties)

Crust – composition (sial/sima), Mantle and Core

4. Earth Process; Endogenic Processes: Driving forces (thermal energy), Earthquake, Tectonics, Volcanos, Fault, folds,

5. Earth Process; Exogenic Processes: Driving forces, Weathering, Erosion, Transportation, Deposition, Agents (wind, river, glacier, ocean0

6. Concepts and Theories in the Earth's Processes: Davisian Cycle of Erosion, Penck and King's Concepts of land formation, Wegner's Continental Drift Theory, Plate Tectonic, Theories of Isostasy and Gravity Tectonics, Kober's Geosynclinal Orogenic Theory

7. The Atmosphere: Composition and Structure, Weather and Climate (Factors and Elements) Isolation, Heat Budgets

8. The Hydrosphere: Definition, Hydrological cycle (ocean water, fresh water), Distribution,

9. The Biosphere, Definition and components, Plant life, Evolution and classification Environmental Factors and Plant Distribution, Animal force, Classification

Recommended Books:

5. Thornbury, W. D., Principles of Geomorphology
6. Sharma, V. K., Geomorphology: Earth Surface, Process and Forms
7. Small, R. J., The Study of Landforms
8. Sparks, B. W., Geomorphology
9. King, L. C., Morphology of the Earth
10. Chorley et. al., Geomorphology
11. Emblemton, C & Thomas J., Process in Geomorphology
12. Holmes, A., Principles of Physical Geology
13. Leopold, W. and Miller, Fluvial Process in Geomorphology

OCN 1105	**Marine Ecology**	**3 CH**

Scope and Objectives:

This course is designed to get knowledge of marine ecology. The main objectives of this course are to learn about various coastal and oceanic ecosystems, the interaction between the biotic and abiotic components of the ecosystem, and to explore how environmental variables, affect the biological communities and ecological interactions.

Learning Outcomes:

Students will be able to recognize various coastal and marine ecosystems at global, regional and local level. Students will acquire a basic knowledge of interaction within various ecosystem components and how ecological and evolutionary adaptation of various species occurs in an ecosystem.

Course Contents:

1. History and scope of ecology, sub-division of ecology, population and community ecology of the marine environment. Zonation of the sea, major ecological divisions of marine habitat.

2. System ecology: definition, structure, component and function of ecosystem, energy and its flow in ecosystem, biogeochemical cycles, aquatic and terrestrial system.
3. The environment: biotic and abiotic parameters, temperature, pH, radiation, atmospheric gases, current and pressures.
4. Interaction between biotic and abiotic components, classification of the interactions, role of biotic factors and community structure, movement, migration and colonization.
5. Marine biota and their distribution, inter relationships between marine fishes with other abiotic and biotic factors.
6. Adaptation of marine organisms to different environment
7. Food chain, food webs and ecological niche in marine environment.

OCN 1106 Marine Ecology Practical 1 CH

Scope and Objectives:
This course provides practical experience to understand different aspects of coastal and marine ecology by observation and recording information. The man aims of this course are to learn about the analysis procedure of ecological data, quantitative study and biodiversity determination of organisms and to determine different ecological parameters of marine environment.

Learning Outcomes:
Having successfully completed this course, students will be able to understand the diversity of coastal and marine ecosystem and to determine biodiversity and zonation of the sea interacted with different ecological parameters.

Course Contents:
1. Preparation of model showing zonation of the sea
2. Quantitative study and biodiversity determination of marine organisms in the open water, coastal water and floor of the sea
3. Laboratory practices in determination of various ecological parameters
4. Determination of DO consumption and Salinity tolerance of aquatic organism.

Recommended books:

1. Odum, E.P., 1971. Fundamentals of Ecology, W.B Saunders Company, USA.
2. Chapman, J.I. and Reiss, M.J., 1995. Ecology, Principles & application, Cambridge University Press, Cambridge.
3. Wootton, R.J., 1991. Fish ecology. Chapman & Hall Publishing Company, New York.
4. Weatherly, A.H., 1972. Growth & Ecology of Fish population. Academic Press, London. New York.
5. Macan, T.T., 1974. Fresh water Ecology. Longmans. London.
6. Moss, B., 1980. Ecology of freshwaters. Blackwell scientific Publication.
7. Tait. R.V. 1972. Elements of Marine Ecology. Butterworths, London.

OCN 1107 Marine Resources 3 CH

Scope and Objectives:
This course is designed to learn about various marine resources i.e. living and non-living resources in ocean. To maintain a sustainable use of resources the understanding of marine

resource is important. The main objectives of this course are to get the knowledge of various living and non-living marine resources and its potentiality and to understand the extraction and sustainable use of marine resources.

Learning Outcomes:
Students will be able to learn about the diversity of marine resources around the world and will understand the contribution of marine resources and its future prospect for sustainable utilization process of marine resources.

Course Contents:

1. Definition, types of marine resources: physical resources, marine energy resources, biological resources, non-extractive resources.
2. Living Resources:
   Marine Invertebrates: status, ecological and economic importance of Sponges, Crustaceans, Mollusks, echinoderms, Corals etc.
   Marine Vertebrates: status, ecological and economic importance of Marine fishes, Marine Reptiles, Sea birds, Cetaceans, Pinnipeds and Marine Otters.
   Plant resources: status, ecological and economic importance of Marine algae, Seagrass, Salt marsh and Mangroves.
   Mariculture (based on shrimp farming): Scope, importance, present status and evolutionary history of Mariculture in Bangladesh.

3. Non-living resources:
   Salt Production: general concept, types of salt, solar salt production processes in Bangladesh. Salt quality, food and other uses in Bangladesh.
   Tourism: Present status and prospects of coastal and marine tourism, Coastal and Marine tourism scope and facilities in Bangladesh (Cox's Bazar, Chittagong, Kuakata and Khulna region).
   Sea Port: Geographical position of Chittagong Sea Port and Mongla Sea Port, history, commercial importance, Facilities and problems.
   Minerals: Introduction, Types, Transportation Deposition, Distribution, Extraction of heavy minerals, Beach heavy minerals in Bangladesh.
   Marine Gas and Oils: General concept, types of gas and oils, formation, distribution, inshore and offshore exploration.

OCN 1108 Marine Resources Practical 1 CH

Scope and objectives:
The course is constructed to give knowledge on identification and sustainable use of marine resources.

Learning outcomes:
Students will be able to get practical knowledge about the diversity of world marine resources. Students will understand the contribution of marine resources and its future prospect.

Course Contents:

1. Museum study of marine resources

2. Collection, Preservation and Identification of marine resources
3. Field and research institutional visit/ tour for resource inventory.

Recommended Books:

1. Sea Life, A complete Guide to the Marine Environment, By G. Waller.
2. Coastal Vegetation, V.J. Chapman.
3. Seaweed Culture in Bangladesh (manual 1&2), M. Zafar.

BLWS 1101 Bangladesh and Liberation War studies 3 CH

Scope and Objectives:
This course is designed to learn about the history of the independence and emergence of Bangladesh.

Learning Outcomes:
Students will be learned about the Country and her People, partition of the sub-continent, the language movement, misrule of Pakistan, movements for self- determination, election of 1970, the 7th March Address, operation searchlight, the declaration of independence by Bangabandhu, and the formation of Bangladesh government and the Victory, formation of the constitution, reconstruction of the war ravaged country.

Course Contents:
ভূমিকা: **স্বাধীন বাংলাদেশের অভ্যুদয়ের ইতিহাস–পরিধি ও পরিচিতি** (Introducing History of the Emergence of Independent Bangladesh and its Scope)

১. দেশ ও জনগোষ্ঠীর পরিচয় (Description of the Country and its People)

ক. ভূ-প্রকৃতির বৈশিষ্ট্য ও প্রভাব (Geographical Features and its Influence)

খ. নৃতাত্ত্বিক গঠন (Ethnical Composition)

গ. ভাষা (Language)

২. উপমহাদেশের বিভক্তি ১৯৪৭, পাকিস্তান রাষ্ট্রের কাঠামো, বৈষম্য, ভাষা আন্দোলন এবং আইয়ুব ও ইয়াহিয়া খানের শাসনামল (১৯৫৮-১৯৭১) (Partition of the Sub-Continent 1947, Structure of Pakistan, Disparity, the Language Movement and the Rule of Ayub-Yahia Khan (1958-1971)

ক. লাহোর প্রস্তাব, ১৯৪০ (Lahore Resolution, 1940)

খ. পাকিস্তান সৃষ্টি, ১৯৪৭ (The creation of Pakistan 1947)

গ. কেন্দ্রীয় ও প্রাদেশিক কাঠামো (Central and Provincial Structure)

ঘ. অর্থনৈতিক, সামাজিক ও সাংস্কৃতিক বৈষম্য (Economic, Social and Cultural Disparity)

ঙ. পাকিস্তানের অপশাসন ও গণতান্ত্রিক রাজনীতির সংগ্রাম (Misrule of Pakistan and Struggle for Democratic Politics)

চ. ভাষা আন্দোলন : পটভূমি ও ঘটনা প্রবাহ (The Language Movement : Context and Phases)

ছ. হক-ভাসানী-সোহরাওয়ার্দীর যুক্তফ্রন্ট, ১৯৫৪ সালের নির্বাচন ও পরিণতি (United Front of Haque-Vasani-Suhrawardi : Election of 1954 and its Consequences)

জ. আইয়ুব খানের ক্ষমতা দখল ও শাসনের বৈশিষ্ট্য (রাজনৈতিক নিপীড়ন, মৌলিক গণতন্ত্র, ধর্মের রাজনৈতিক ব্যবহার) [Ayub Khan's Rise to Power and Characteristics of His Rule (Political Repression, Basic Democracy, Islamisation)]

ঝ. আইয়ুব খানের পতন ও ইয়াহিয়া খানের শাসন, এক ইউনিট বিলুপ্তিকরণ, সর্বজনীন ভোটাধিকার, এলএফও (Fall of Ayub Khan and Yahia Khan's Rule, Abolition of One Unit, Universal Suffrage, LFO)

৩. জাতীয়তাবাদের বিকাশ, স্বাধিকার আন্দোলন (Rise of Nationalism and the Movement for Self-Determination)

ক. শেখ মুজিবুর রহমানের ৬-দফা আন্দোলন (The Six Point Movement of Sheikh Mujibur Rahman)

খ. ৬-দফা আন্দোলনের প্রতিক্রিয়া, গুরুত্ব ও তাৎপর্য (Reactions, Importance and Significance of the Six Point Movement)

গ. আগরতলা মামলা, ১৯৬৮ (The Agartala Case, 1968)

ঘ. ছাত্রদের ১১-দফা আন্দোলন (Students' 11-Points Movement)

ঙ. ১৯৬৯-এর গণঅভ্যুত্থান (The Mass-Upsurge of 1969)

৪. **১৯৭০ সালের নির্বাচন, অসহযোগ আন্দোলন ও বঙ্গবন্ধুর স্বাধীনতা ঘোষণা** (Election of 1970, Non-cooperation Movement of March 1971 and the Declaration of Independence by Bangabandhu)

ক. নির্বাচনের ফলাফল এবং তা মেনে নিতে কেন্দ্রের অস্বীকৃতি (Election Result and Central's Refusal to Comply)

খ. অসহযোগ আন্দোলন, বঙ্গবন্ধুর ৭ই মার্চের ভাষণ, অপারেশন সার্চলাইট (The Non-cooperation Movement, the 7th March Address, Operation Searchlight)

গ. বঙ্গবন্ধুর স্বাধীনতা ঘোষণা ও গ্রেফতার (Declaration of Independence by Bangabandhu and His Arrest)

ঘ. স্বাধীনতার ঘোষণাপত্র ও বাংলাদেশ সরকার গঠন (The Proclamation of Independence and the Formation of Bangladesh Government)

৫. মুক্তিযুদ্ধ ও স্বাধীন বাংলাদেশের প্রতিষ্ঠা (The War of Liberation and Formation of Independent Bangladesh)

ক. স্বতঃস্ফূর্ত প্রাথমিক প্রতিরোধ ও সংগঠিত প্রতিরোধ (মুক্তিফৌজ, মুক্তিবাহিনী, গেরিলা ও সম্মুখ যুদ্ধ) [The Spontaneous Early Resistance and Subsequent Organized Resistance (Mukti Fouj, Mukti Bahini, Guerillas and the Frontal Warfare)]

খ. গণহত্যা, নারী নির্যাতন, শরণার্থী (Genocide, Repression of Women, Refugees)

গ. মুক্তিযুদ্ধে প্রচার মাধ্যম (স্বাধীন বাংলা বেতার কেন্দ্র, বিদেশি প্রচার মাধ্যম ও জনমত গঠন) [Publicity Campaign in the War for Liberation (*Swadhin Bangla Betar Kendra*, the Campaigns Abroad and Formation of Public Opinion)]

ঘ. দখলদার বাহিনী, শান্তি কমিটি, আল-বদর, আল-শামস, রাজাকার বাহিনী, রাজনৈতিক দল ও দেশীয় অন্যান্য সহযোগীদের স্বাধীনতা বিরোধী কর্মকাণ্ড ও বুদ্ধিজীবী হত্যা (The Anti-Liberation Activities of the Occupation Army, the Peace Committee, AL-Badar, Al-Shams, Rajakars, Pro-Pakistan Political Parties and Pakistani Collaborators, Killing of the Intellectuals)

ঙ. পাকিস্তানে বন্দী অবস্থায় বঙ্গবন্ধুর বিচার ও বিশ্ব প্রতিক্রিয়া (Trial of Bangabandhu in Pakistan and Reaction of the World Community)

চ. মুক্তিযুদ্ধে ভারতের অবদান ও আন্তর্জাতিক সম্প্রদায়ের ভূমিকা (The Contribution of India in the Liberation War and the Role of International Communities)

ছ. যৌথবাহিনী গঠন ও বিজয় (Formation of Joint Command and the Victory)

জ. বঙ্গবন্ধুর স্বদেশ প্রত্যাবর্তন (Homecoming of Bangabandhu)

ঝ. সংবিধান প্রণয়ন (Formation of the Constitution)

ঞ. যুদ্ধবিধ্বস্ত দেশ পুনর্গঠন (Reconstruction of the War Ravaged Country)

ট. স্বাধীনতা বিরোধীদের ষড়যন্ত্র ও বঙ্গবন্ধুর হত্যা (Conspiracy of the Anti-Liberation Activists and the Murder of Bangabandhu)

সহায়ক গ্রন্থাবলি

আশফাক হোসেন : *বাংলাদেশের অভ্যুদয় ও জাতিসংঘ*

এইচ টি ইমাম : *বাংলাদেশ সরকার ১৯৭১*

গোলাম মুরশিদ : *মুক্তিযুদ্ধ ও তারপর : একটি নির্দলীয় ইতিহাস*

গোলাম মুরশিদ : *হাজার বছরের বাঙালি সংস্কৃতি*

নীহাররঞ্জন রায় : *বাঙ্গালীর ইতিহাস*, আদি পর্ব

বেলাল মোহাম্মদ : *স্বাধীন বাংলা বেতার কেন্দ্র*
মঈদুল হাসান : *মূলধারা ৭১*
মওদুদ আহমেদ : *শেখ মুজিবুর রহমানের শাসনকাল*
মুনতাসীর মামুন : *স্বাধীন বাংলাদেশের অভ্যুদয়ের ইতিহাস*
মোঃ মাহবুবর রহমান : *বাংলাদেশের ইতিহাস, ১৯৪৭-১৯৭১*
শেখ মুজিবুর রহমান : *অসমাপ্ত আত্মজীবনী*
সৈয়দ আতিকুল ইসলাম ও অন্যান্য :*স্বাধীন বাংলাদেশের অভ্যুদয়ের ইতিহাস*
সৈয়দ আনোয়ার হোসেন : *বাংলাদেশের স্বাধীনতা যুদ্ধে পরাশক্তির ভূমিকা*
হারুন-অর-রশিদ : *বাঙ্গালির রাষ্ট্রচিন্তা ও স্বাধীন বাংলাদেশের অভ্যুদয়*
A A K Niazi : *The Betral of East Pakistan*, Karachi: Oxford University Press, 1998.
Anthony Mascarenhas: *The Rape of Bangladesh*, New Delhi: Vikas, 1971.
Archer K Blood : *The Cruel Birth of Bangladesh: Memoirs of an American Diplomat*, Dhaka: UPL, 2002.
Sucheta Ghosh : *The Role of India in the Emergence of Bangladesh,* Calcutta: Minerva Associates Pvt. Ltd., 1983.

OCN 1102	**Field Trip**	**1 CH**

First Year
Semester II

OCN 1201	**Introduction to Atmospheric Science**	**3 CH**

Scope and Objectives:
The course is designed to provide a general knowledge and interdisciplinary understanding of the Earth's atmosphere and air-sea interaction with along with different atmospheric disturbances.

Learning Outcomes:
Students will acquire fundamental knowledge of atmosphere, the Energy of the atmosphere, atmospheric variables, atmospheric motions, and circulation, thunderstorm, tornadoes, tropical Cyclones.

Course Contents:
1. Introduction to Atmosphere: Structure and Present Composition, Characteristics of the Gases - Carbon dioxide, Ozone

2. The Energy of the Atmosphere: Isolation & Temperature: Factors & Controls, Transfer of Energy, The Earths Heat Balance, Spatial & Temporal Variation of Temperature, Inversion of Temperature, Air Pressure, Causes, Horizontal & Vertical Variation of Pressure

3. Atmospheric Moisture: Humidity- Moisture Variables; The Hydrologic Cycle, Evaporation and Condensation, Condensation Forms: Clouds, Fogs, Precipitation: Formation and Types

4. Atmospheric Motions: Forces Controlling Motion, Winds of the Atmosphere: Geostropic, Gradient, Friction Layer and Vertical Wind, Temperature and Air Motions, Adiabatic Processes, Air Stability, Relationship between Vertical and Horizontal Motion

5. Atmospheric Circulation and Scales of Motion: Planetary Scale, Tricellular Model and General/Planetary Circulation, Jet streams, ITCZ and the Monsoon Wind System, Land &

Sea Breeze, Mountain & Valley Winds, Thunderstorm & Tornadoes

6. Atmospheric Disturbances: Air Mass and Fronts, Frontal Wave Theory of Cyclogenisis Cyclones (Tropical) and Anticyclone.

7. Air-Sea interaction/ exchange.

Recommended Books:

Barrry, R.G., and R.J. Chorley, Atmosphere, Weather and Climate, Methuen & Co.
Barry, R.G., Atmosphere, Weather and Climate (6th edit.)
Critchfield, H.J., General Climatology. 3rd ed. Englewood Cliffs, N.J. Prentice Hall.
Hare, F. K., The Restless Atmosphere (Rev. edit.). New York: Harper & Row Publishers Inc.
Mather, J. R., Climatology. Fundamentals and Applications. New York: McGraw Hill Book Co.
Riehl, H., Introduction to the Atmosphere. 3rd ed. New York: McGraw Hill Book Co.Inc.
Stringer, E.T., Foundations of Climatology. San Francisco: W. H. Freeman & Co.
Trewartha, G.T. and Horn, L.H., An Introduction to Weather and Climate. 5th ed. McGraw-Hill Book Co. Inc.
Strahler, A.N., Physical Geography. Wiley, New York
Pettersen, S., Introduction to Meteorology, New York: McGraw-Hill Book Co., Inc.
Conrad V., Methods in Climatology. 2nd ed. Harvard University Press, Cambridge
W.M.O., Guide to Metrological Instruments and Observing Practice. 3rd ed., Geneva:
Oliver, John E., Climatology: An Atmospheric Science (2001)

OCN 1203	**Marine Invertebrates**	**3 CH**

Scope and Objectives:

This course is designed to get the knowledge about the marine invertebrate organisms.The main objectives of this course are to learn about various phylum of invertebrate organisms, to develop the knowledge of diversity and classification of organisms and understanding of internal and external structure and functionality of the organisms.

Learning Outcomes:

Students will be able to understand the diversity of marine invertebrate organisms, taxonomy and classification process and will also know the structure, function and evolutionary trend of the marine invertebrate organisms.

Course Contents:

1. Classification of marine invertebrates: Identification, Classification, Taxonomy, Salient features of major invertebrates
2. Anatomy of major marine invertebrates: Protozoa, Porifera, Coelenterate, Ctenophore, Rotifer, Annelida, Mollusca, Arthropoda, Echinodermata
3. Organ systems of major marine invertebrates: Digestive system, Reproductive system, Respiratory system, Circulatory system and Excretory system
4. Distributional pattern of major phyla in the marine environment
5. Ecology of different marine invertebrates.

OCN 1204	Marine Invertebrates Practical	1 CH

Scope and Objectives:
This course provides the practical experience to understand different aspects of marine invertebrate species. The main aims of this course are to recognize the body of major phyla, their classification and to understand external and internal characteristics of these species.

Learning Outcomes:
Students will be able to recognize different marine invertebrate species as well as their internal and external characteristics and will learn the classification of major phylum of marine invertebrates.

Course Contents:

1. Collection, preservation and identification of invertebrates
2. Study of external morphological features of marine invertebrates
3. study of external and internal anatomy of higher marine invertebrates
4. Museum study of marine invertebrates-corals, sea urchin, sea anemones, crustaceans, mollusks, Polychaeta etc.

Recommended books

1. A manual of practical zoology: Invertebrate, by Verma et al, 1997
2. Practical invertebrate zoology, edited by RP Dales, 1981
3. General zoology, by TI Storer and RL Usinger, 1965
4. Zoology, by EL Cockrum and WJ McCauley, 1965
5. Marine fauna and flora of Burmuda, edited by W Sterrer, 1986

OCN 1205	Mathematics for Oceanographer	3 CH

Scope and Objectives:
This course is designed to introduce students with the fundamental concepts of modern mathematics with an emphasis on the underlying foundations of mathematics. The use and understanding of mathematical theories will allow students to develop analytical skills which will form a base for further study. The main objectives of this course are to develop deep mathematical understanding of students, to formulate problems and develop student's problem-solving skills and to enhance student's ability to reason logically and think creativity.

Learning Outcomes:
Students will be able to find roots of algebraic equations and the relation between roots and coefficients. They will able to determine domain and range of different types of functions, to analyze and find limiting value of a function, to differentiate any function and apply these techniques to solve real world problems. Student's will also learn to explain integration and integrating rules, applying various techniques to evaluate indefinite and definite integrals and to solve different geometrical problems.

Course Contents:
Algebra
1. Set theory: Sets, Null sets, subsets, disjoint sets, Universal sets, power set, Venn diagrams, basic set operations such as union, intersection, difference, complements
2. Theory of equation: Relation between roots and co-efficient, increasing and decreasing of

roots, sum of power of roots, formation of equation, Idescartes rule of sign
3. Matrix: Definition of different matrices, rule of multiplication of matrices, ad joint matrix, inverse matrix, hermit Ian matrix, orthogonal matrix, solution of linear equations

Calculus

1. Differential Calculus: Limits, continuity and differentiability; Successive differentiation of various types of functions; Leibnitz's Theorem; Rolle's Theorem; Mean value Theorem; Taylor series, Maclaurine series, Expansion of functions; Evaluation of indeterminate forms by L'Hospitals rule; Partial differentiation; Euler's Theorem; Tangent and Normal; Maximum and minimum values of functions of single variable; Curvature, Asymptotes, Envelopes.
2. Integral Calculus: Definitions of integration; Integration by the method of substitutions; Integration by parts; Standard integrals; Integration by the method of successive reduction; Definite integrals and its use in summing series, Improper integrals, Beta function and Gamma function; Area under a plane curve; Area of the region enclosed by two curves; Volume of solids of revolution; multiple integrals and its application.

Vector Analysis

Scalars and vectors, Algebraic operations on vectors, Components of vectors, vectors products, angel between two vectors, Derivatives of vectors, Gradient, divergence and curl, vector integrals

OCN 1207 Marine Vertebrates 3 CH

Scope and Objectives:

This course is designed to get the knowledge about the marine vertebrate organisms. The major aims of this course are to learn about various marine vertebrate organisms, to develop the knowledge on diversity, classification and evolution of the organisms, to get the understanding on internal and external structure and functionality of the organisms and to understand the ecology and different processes such as feeding, reproduction, behavior, migration etc.

Learning Outcomes:

Students will be able to understand the taxonomy and classification of process, and diversity of marine vertebrate organisms. Students will know the structure, function and evolutionary trend of the marine vertebrate organisms and finally students will be able to understand the ecology and different processes such as feeding, reproduction, behavior, migration etc.

Course Contents:

1. Introduction to Ichthyology, importance and methods of the study of fishes, opportunities of Ichthyology
2. Evolutionary history of fishes and other marine chordates
3. Classification of marine chordates with special reference to fishes
4. Habitat, movement, skeleton, skin, alimentary system, circulation, excretory system, nervous system, gonads & gonadal development etc of Ascidia, amphioxus, Petromyzon
5. Geographical distribution of fishes
6. Organ systems of fish
   - 6.1 The skeleton: Notochord and vertebral column, Skull, Pectoral and Pelvic, Fins, Dermal skeleton, Teeth

6.2 The Musculature: Somatic musculature, Visceral musculature
6.3 The body cavity
6.4 The digestive system: divisions of digestive tract, Large bladder, Weberian apparatus
6.5 The Urogenital organs: Kidney, Gonads, Cloaca, Genital organs, Secondary sex-characters
6.6 Circulatory system: Blood, Structure and function of the blood vessels, Blood vessels system, Blood purification
6.7 Respiratory system: Gills, Accessory respiratory organs, Gas-exchange method
6.8 Sensory organs
6.9 Nervous system: central nervous, peripheral nervous system, cranial and bronchial nerves
6.10 Integumentary system: skin, epidermis, dermis

7. Osmoregulation
8. Migration
9. Sea birds (gulls, pelicans, gannets, cormorants, albatross, petrels): Classification, distribution and economic importance.
10. Marine reptiles (turtles, snakes): Classification, distribution and economic importance.
11. Marine mammals (wheals, dolphins, porpoise, seal): Classification, distribution and economic importance.

OCN 1208 Marine Vertebrates Practical 1 CH

Scope and Objectives:
This course provides the practical experience to understand different aspects of marine vertebrate species. The main aims of this course are to identify different species of marine vertebrates and to understand the external and internal characteristics of species and their classification.

Learning Outcomes:
Having successfully completed this course, students will be able to identify different marine vertebrates with their internal and external characteristics and learn the classification.

Course Contents:

1. Collection, preservation and identification of marine chordates
2. Study external and internal anatomy of marine chordates
3. Study of external morphology of fishes
4. Dissection and study of the basic organ systems of fish-skeletal alimentary, circulatory, nervous, respiratory excretory and reproductive system
5. Museum study of marine vertebrates-Reptiles, fishes and birds

Recommended books

1. Ichthyology, by CF Lagler et al
2. Chordate Zoology, by Storer and Usinger
3. Chordate Zoology, by Velly and Walker

ENG 1201	Communicative English	2 CH

Scope and Objectives:
This course will provide fundamental aspects of English reading, writing, listening and speaking skills. The course will help students to develop their language and communication skills through interactive participation in the class. The major objectives of this course are to improve academic writing reading skills and understanding of short text in English. Students will also enrich their vocabulary and will improve their listening and speaking skills as well as their grammatical knowledge.

Learning Outcomes:
Students will be able to utilize the strategies of free hand writing in other courses, speak more accurately and fluently, communicate with native and nonnative speakers much efficiently, find out key ideas reading long text and to improve critical thinking skills and write grammatically correct sentences.

Course Contents:

1. Functional Grammar
   - 1.1 Parts of Speech, Articles, Tense, voice, Narration, Appropriate preposition, Syntax and corrections
2. Developing Reading Skills
   - 2.1 Methods of developing reading skills
   - 2.2 Practicing reading comprehension using different reading selections from science, history, linguistics or other areas
   - 2.3 A training on summarizing and finding main points of text
3. Developing Writing Skills
   - 3.1 Writing free and guided composition
   - 3.2 Letter and essay writing
   - 3.3 Translation from Bangla to English and English to Bangla
   - 3.4 Use of countable and non-countable nouns
   - 3.5 Should/would/so/too, either/neither; real/unreal conditions, have/get, subjective, inclusive, problem verbs (rise, raise, lie, sit), gerunds, dangling participles, redundancy and parallel structure in formal written English
4. Developing Speaking Skills
   - 4.1 Practicing speaking English on the situation which may be encountered in everyday life and education

Recommended books

1. Advanced Learner's Functional English, by MYA Chowdhury and MM Hossain
2. English Grammar & Composition, by Wren and Martin
3. A Potential Communicative English Grammar & Composition, by M Khalil Ullah

COMP 1201	Computer Application	3 CH

Scope and Objectives:
The major aims of this course are to learn about the basic of computer, various applications of software and programming. Student's will able to define a problem, plan a solution, code the program, test and finally document the program.

Learning Outcomes:
Students will be able to know basic of computing and programming, they could able to define problems, code the program and solve the problem.

Course Contents:

1. Introduction
   - 1.1 Introduction to computer hardware, software, types, capabilities
   - 1.2 Application of computers
2. Computing
   - 2.1 System software: definition, Operating Systems and system utilities, components of OS, shell, UI, essential file and printing services
   - 2.2 Application software
     - 2.2.1 Definition, major types
     - 2.2.2 Case types: Word processing, Worksheet management, Database management, Presentation graphics, Image/photo editing, Statistical package, Internet clients (mail, web, telnet, ftp)
     - 2.2.3 Other major types: Multimedia, Games and entertainment, reference, CAD/CAM, GIS, Networking and Communication
3. Social, ethical issues in computing: crime, virus, legal issues, privacy, concept of intellectual property and software piracy, misuse, loss and/or generation of employment, etc.
4. Specific software for ocean studies e.g. SURFER, MATLAB

COMP 1202	**Computer Application Practical**	**1 CH**

Scope and Objectives:
The course is designed to give the students a practical training of various aspects of different applications of computer science and its applicability in the field of oceanography.

Learning Outcomes:
Students will be used to operating system and exercise of specific application software for ocean studies.

Course Contents:

1. Using OS: File and printing services
2. Word processing using Microsoft Word
3. Spreadsheet exercises using Microsoft Excel
4. Data analyses and graphing using Excel
5. Making presentation using Microsoft PowerPoint
6. Database design using Microsoft Access
7. Internet clients: Internet Explorer, Outlook express
8. Exercise of specific application software for ocean studies

Recommended books

1. Introduction to Computer Science and BASIC programming, by S Jain. BPB Publications, India.

	Viva Voce	**2 CH**

First Semester	2nd Year	
Course Code	**Course title**	**CH**
OCN 2101	Physical Oceanography	3
OCN 2102	Physical Oceanography Practical	1
OCN 2103	Biological Oceanography	3
OCN 2104	Biological Oceanography Practical	1
OCN 2105	Coastal and Marine Aquaculture	3
OCN 2106	Coastal and Marine Aquaculture Practical	1
OCN 2107	Statistical techniques for Oceanographers	3
OCN 2108	Statistical techniques for Oceanographers practical	1
OCN 2109	Marine Environment and Climate Change	3
OCN 2110	Field Trip	1
	Total	**20**

Second Semester	2nd Year	
Course Code	**Course title**	**CH**
OCN 2201	Chemical Oceanography	3
OCN 2202	Chemical Oceanography Practical	1
OCN 2203	Marine Microbiology	3
OCN 2204	Marine Microbiology Practical	1
OCN 2205	Coastal Morphology and Estuarine Process	3
OCN 2206	Coastal Morphology and Estuarine Process Practical	1
OCN 2207	Oil, Gas and Renewable Energy	3
OCN 2209	Marine Biochemistry	3
OCN 2210	Marine Biochemistry Practical	1
OCN 2212	Viva Voce	2
	Total	**21**

Second Year
Semester I

OCN 2101	**Physical Oceanography**	**3 CH**

Scope and Objectives:
The course is designed aiming to give the students and understanding of the various physical aspects of the ocean including ocean circulation (wave and currents), tides, physical properties of sea water, heat and other properties and the dynamic processes which control the movement of water as well as the roles of ocean circulation and other properties of ocean.

Learning Outcomes:
Student will be able to understand the physical processes that control the distribution of water properties and the dynamics of those properties in the ocean.

Course Contents:

1. Physical properties of sea water: Pressure and depth, Accuracy and precision, Temperature and potential temperature, Heat budget, Concept of salinity, Electrical conductivity, Density, potential density and neutral density, T-S diagram, Mixed layer depth
2. Distribution of temperature in ocean: Surface distribution, Vertical distribution, Meridional distribution
3. Sound and light in sea water: Propagation, attenuation, diffusion, extinction, Upwelling and downwelling of light, color of sea
4. Sea Ice: Freezing point and temperature of maximum density, effect of salinity, freezing in shallow seas and lakes, properties and types of sea ice
5. Water, salt and heat budget and flux: Hydrologic cycle, Conservation of Mass, Salt and Energy, Heat fluxes and heat balance
6. Ocean Wave: Classification of waves, Wave parameters, spectrum of surface waves, , Wind waves and swells, Wave theories: Small amplitude wave theory, Wave refraction, defraction, reflection
7. Astronomical Tides: Causes of tide: centrifugal force and gravitational attraction, tidal potential, Effects of sun-moon system on tide: distance, declination and nutation, diurnal inequality, Types of tide, Tidal datums
8. Ocean Current: Definition, Types, Causes, oceanic gyre, Meso-scale eddies
9. Ocean circulation: Wind driven surface circulation: wind stress, Coriolis force, Ekman's spiral and net transport, Vertical circulation: Upwelling and downwelling
10. Dynamics of physical Oceanography: Classification of forces and types of motion in the sea, Kinematics of fluid flow, equation of continuity and applications, Equation of motion in oceanography

OCN 2102 Physical Oceanography Practical 1 CH

Scope and Objectives:
Physical Oceanography Practical course is designed to develop the field work, computation and measurement capability of the students. The aim of the course is to give a hands on experience on the data collection processes in physical oceanography using various instruments, to measure physical properties of sea water, computation of different parameters, prepare plots and diagram of analysis.

Learning Outcomes:
Student you will be able to develop fieldwork based skill, various instrumentation techniques and observational methods.

Course Contents:
1. Measurement of seawater properties: Salinity, Electrical Conductivity, Density
2. Calculation of various water properties from known parameters: Salinity, EC, Density, σt and $\sigma s,t,p$, Sound velocity, Pressure, Depth, Specific heat, Adiabatic lapse rate, Freezing point, Potential temperature, Potential density, Temperature of maximum density etc.
3. Use of TS diagram to (i) derive salinity, density and temperature, (ii) to examine water masses and their mixing
4. Making profile: Temperature, salinity, density, Electrical Conductivity etc.
5. Making profile: Temperature, salinity, density, Electrical Conductivity etc.
6. Problems relating to wave theory and wave parameters

Recommended Books

1. The Oceans, by HU Svedrup, MW Johnson and RH Flemming. Prentice-Hall, 1942.
2. General Oceanography: An Introduction (Second English Edition), by Dietrich, Kalle, Krauss and Siedler, John Wiley & Sons. 626pp. 1980.
3. Descriptive Physical Oceanography, 2nd Ed. by GL Pickard, GL. Pergamon Press. 214. 1975.
4. Introduction to Physical Oceanography, by RH Stewart. 342pp. 2002.
5. Principles of Physical Oceanography, by G Neuman, Prentice-Hall.
6. Elements of Physical Oceanography, by HJ McLellan, Pergamon Press. 151pp. 1968

OCN 2103	Biological Oceanography	3 CH

Scope and Objectives:
Biological Oceanography cover basic aspects of marine biology including the processes governing the distribution, abundances, productivity and reproduction of plants, animals, and nutrients in the oceanic ecosystem, the roles of marine organisms on ocean and earth's eco-systems as well as on society.

Learning Outcomes:
The aim of the course is to provide an introduction to different flora and fauna of the ocean including plankton, fishes and benthos. Student will learn about classification, characteristics, the diversity and distribution, importance and life cycle of marine organisms.

Course Contents:
Plankton

1. Definition, classification, morphology and importance of plankton
2. Phytoplankton and zooplankton classification, occurrence and distribution in the Bay of Bengal and major three oceans
3. Factors affecting the growth and abundance of Phytoplankton and zooplankton in the coastal and open water
4. Productivity measurement of phytoplankton

Benthos

5. Definition, classification of benthos in the ocean
6. Benthic communities and their distribution of seafloor
7. Benthic flora and fauna and their vertical stratification, aerobic and anaerobic organisms

Coral Reefs

8. Definition, classification of corals, mechanism of coral formation
9. Ecology, types and distribution of coral reef

Mangroves

10. Definition, classification, zonation, ecological role of mangroves.

OCN 2104	Biological Oceanography Practical	1 CH

Scope and Objectives:
This course is designed to give a practical knowledge of marine biology.

Learning Outcomes:
The aim of the course is to provide the students a hands on experience to collect, preserve

different different marine organisms. Student will be able to identify, collect and preserve marine organisms and estimate their productivity.

Course Contents:
Collection, preservation and identification of plankton and benthic organisms

1. Estimation of productivity, POC, DOC and Biomass
2. Preparation of plankton and benthos slides
3. Culture of Phytoplankton and zooplankton
4. Field trip for studying the marine aquarium and its operation

Recommended books:

1. Ecology of Plankton, A. Kumar.
2. Biological Oceanographic Processes, T.R. Parsons, M. Takahashi and B. Hargrave.

OCN 2105 Coastal and Marine Aquaculture 3 CH

Scope and Objectives:
The course is designed to provide a general knowledge and interdisciplinary understanding of aquaculture specially in production of coastal and marine aquatic organisms, with focus on fishes, shrimp, crabs, mussels, clams, oysters, abalone, scallop, squid, green turtle and seaweed.

Learning Outcomes:
Students will acquire fundamental knowledge of the aquaculture, siteand species selection, genetics, breeding and seed production, farming techniques, farm operation and maintenance, diseases and health management, and nutrition, feed types, main feed sources and principles for their evaluation and formation.

Course Contents:

1. Introduction, objectives, history, present status, role, scope and recent advance in coastal and marine aquaculture in Bangladesh. Types of aquaculture systems, and levels of aquaculture industries.
2. Site selection: Selection of site for different types of aquaculture, basic criteria for suitable site. Accessibility and infrastructure; legal framework; socioeconomic and political issues; conflicts with other water/land uses;
3. Designing, layout and construction of aqua farms; soil properties, water supply and drainage systems; design and construction of hatcheries; aeration in aquaculture types and design; equipment, automatic feeders; etc.
4. Species selection: Basic criteria for suitable species, genetic selection of cultivable species, commonly cultivable species of marine fishes, crustaceans, mollusks and seaweeds, indigenous and exotic species, Biological features of commonly cultured crustaceans and mollusks.
5. Seed production: Wild seed collection, sorting, preservation and transportation of natural seed, larval rearing of marine finfishes, prawns and other marine organisms.
6. Preparation and management of sea farm: Control of predators, aquatic vegetation, and weed fishes, biofouling, fertilization, harvesting.
7. Culture techniques of marine fishes, shrimp, crabs, mussels, clams, oysters, abalone, scallop, squid, green turtle and seaweed.
8. Farming techniques in various zones of sea, pen culture, cage culture, raft culture etc. Pearl culture-life cycle of pearl oyster, techniques of pearl culture.

9. Diet formulation and feeding.

Marine aquarium and park organisms

1. Classification, Ecology and distribution of aquarium and park organisms
2. Breeding and nursing of aquarium and park organisms
3. Teaching methods of aquarium organisms
4. Engineering, operation and management of aquarium organisms.

OCN 2106 Coastal and Marine Aquaculture Practical 1 CH

Scope and Objectives:
The course is designed to provide a practical knowledge of production of coastal and marine aquatic organisms.

Learning Outcomes:
Students will be able to analyze Water and soil, design farms, prepare project profile for hatchery and grow out farm, monitor water parameters in culture systems, formulate feed and make feeding ration.

Course Contents:

1. Water and soil analysis of aquaculture farms
2. Design and layout of aquaculture farms
3. Study of development stages of commercially important shrimps and fishes
4. Preparation of project profile for hatchery and grow out farm
5. Practice of seed collection, sorting, preservation and transportation
6. Monitoring of water parameters in hatchery, nursery and grow-out ponds
7. Feed and feeding ration
8. Study tour to observe culture methodology of fin-fish, shellfish, molluscs and seaweeds in coastal areas of Bangladesh
9. Collection of pituitary gland & preparation

Recommended Books

1. De Silva, S.S. 1998. Tropical mariculture. Academic Press: San Diego, CA (USA)
2. Coastal shrimp aquaculture in Thailand: Key issues for research, edited by PT Smith, ACIAR Technical Report 47, Australia, 1999
3. Timmermans, J.A. Textbook of Fish Culture: Breeding and Cultivation of Fish
4. Pillay, T.V.R. 2005: Aquaculture: Principles and Practices. Fishing News books Ltd.
5. Bardach, E.J. Rhyther, J.H. & W.O. Mc. Larney. 1972: Aquaculture. The Farming and Husbandry of freshwater and Marine organisms. John Wiley and Sons. New York: p 868.

OCN 2107 Statistical Techniques for Oceanographers 3 CH

Scope and Objectives:
The course is designed to provide a general overview of statistics including presentation of data, correlation and regression, Probability distribution, sampling, basic ideas of test, experimental design, Test of significance, time series and forecasting.

Learning Outcomes:
Students will acquire fundamental knowledge of statistics.

Course Contents:

Definition, scope and importance of statistics in oceanography

1. Presentation of data.
   - 1.1 Introduction
   - 1.2 Types of data, tabulation of data, frequency and frequency distribution, construction of frequency distribution table
2. Graphical Representation
   - 2.1 Introduction of graph, types of graphs
3. Measures of Central Tendency
4. Measures of Dispersion
   - 4.1 Introduction, different types of dispersion
5. Moments, Skewness and Kurtosis
   - 5.1 Introduction, Definition and types of Skewness and Kurtosis, Absolute and relative measures of Skewness, Measures of Kurtosis, Use of Moments in Skewness and Kurtosis
6. Correlation and Regression
   - 6.1 Correlation: Coefficient of correlation, Simple correlation, Rank correlation, Coefficient of determination
   - 6.2 Regression: Regression coefficient, Simple regression, Multiple regression, Polynomial Regression
   - 6.3 Use of regression and correlation analysis: Limitations and Errors
7. Probability Distribution
   - 7.1 Basic concept of probability, Related mathematics, Elementary Probability and Conditional probability
   - 7.2 Probability distribution, Random variable & Expected value in Decision making
   - 7.3 Properties, constants and significance of Binomial distribution, Poisson distribution and Normal distribution
8. Sampling
   - 8.1 Introduction to sampling, population and sample, types of sampling- Judgment sampling and Probability sampling
   - 8.2 Random sampling: simple random sampling, stratified random sampling, systematic sampling and there uses, Sample estimates and its variances, Standard errors of estimates, Sampling and non-sampling errors
9. Basic ideas of test
   - 9.1 Introduction: hypothesis, null hypothesis, alternative hypothesis, label of significance, confidence limit
   - 9.2 ‘t’ distribution, properties of ‘t’ distribution application of ‘t’ distribution, ‘t’ tests
   - 9.3 The X^2 distribution, constants of X^2 distribution, X^2 test, conditions for applying X^2 tests, uses of X^2 tests

     The F distribution, some special characteristics of F distribution, application of F tests, Analysis of variance, Assumption of analysis of variance, techniques of analysis of variance, techniques of analysis of variance one way and two way classification models for ANOVA.
10. Experimental design
    - 10.1 Introduction, Phases of experimental design
    - 10.2 Randomized block design
    - 10.3 The Latin squire design
11. Test of significance

11.1 Introduction, hypothesis, null hypothesis, alternate hypothesis, level of significance, one tailed and two tailed test, power of a test, construction of confidence intervals.

11.2 Special applications: Tests about means, proportions & correlation coefficient, Test of goodness of fit, independence & homogeneity, Test in regression analysis

12. Non parametric tests: Introduction, advantage of non-parametric tests, rank sum test, Mann- Whitney test, Spearman's rank Correlation, Kolmogorov-Smirnov sample test, Wilcoxon Signed Rank test

13. Time series and forecasting: Introduction, utility and components of time series analysis, measurements of trends, Graphic method, methods of semi averages, methods of moving averages, the methods of least squires, second degree parabola, exponential trends, growth curves, measurement of seasonal variations.

OCN 2108 Statistical Techniques for Oceanography Practical 1 CH

Scope and Objectives:
The course is designed to provide knowledge of different statistical methods to be used in oceanography.

Learning Outcomes:
Students will be able to use different statistical methods in oceanographic analysis.

Course Contents:

1. Graphical representation of data, measures of location, dispersion, moments, Skewness, Kurtosis.
2. Calculation of single correlation coefficient, simple regression coefficient, scatter diagram, multiple and polynomial analysis.
3. Analysis of variance: one way and two way
4. Problems on 't' test, F test, X^2 test
5. Time series analysis linear trend line, polynomial trend line, moving average method, seasonality analysis
   5.1 Problems on different types of tests: Tests about means, proportions & correlation coefficient
   5.2 Test of goodness of fit, independence & homogeneity
   5.3 Test in regression analysis
6. Special tests
   6.1 DMRT for growth performance test
   6.2 Non-parametric tests: Chi-squire test, K related test
7. Trend analysis and seasonal variation test of supplied data

Recommended Books

1. Methods of statistics, by MG Mustafa
2. Research methodology and statistical techniques, by S Gupta
3. Statistical methods, by SP Gupta
4. Statistics for management, by RI Levin and DS Rubin
5. Designs and analysis of experiments, by DC Montgomery
6. Fundamentals of bio-statistics (biometry), by S Prasad, 1992
7. Statistical methods in biology, byNorman and Bailey, 1995

8. Biometry, by RR Sokal and FJ Rohlf, 1981.

OCN 2109	Marine Environment and Climate Change	3 CH

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

Learning Outcomes:
Students will gather knowledge on the Earth's climate and ocean climate interactio as well as different climatic phenomena.

Course Contents:
1. Introduction, History of Earth Climate
2. History & causes of Climate Change
3. Climate Cause & Prediction
4. Climate Consequences & Biosphere
5. Mitigation Strategies: Transportation
6. Electric Power & Other Sectors
7. Economics of Climate Change
8. Legalities of Climate Change
9. Culture & Climate Change
10. Ocean Climate Service
11. IPCC report
12. Climate change and Sea level
13. Different climatic phenomena-El Nino, La Nina, IOD, PDO, NAO etc.,
14. Ocean acidification and rapid changes in ocean chemistry.

Recommended Books:
1. Climate Change: The Science of Global Warming and Our Energy Future by Edmond Mathez Hardcover: 344 pages Publisher: Columbia University Press (1st edition, 2009) ISBN: 0231146426
2. Climate Change: Picturing the Science by Gavin Schmidt, Joshua Wolfe, and Jeffrey D. Sachs Hardcover: 320 pages Publisher: W. W. Norton & Company (1st edition, 2009) ISBN: 0393331253

OCN 2110	Field Trip	1 CH

Second Year
Semester II

OCN 2201	Chemical Oceanography	3 CH

Scope and Objectives:
This course will give a basic introduction to chemical oceanography and elements seawater, their origin, cycling, behaviour, effects, as well as identifying processes causing their distribution and variation. The course currently includes core and special topics in marine chemistry as composition of seawater and seawater chemistry, marine biogeochemical cycles.

Learning Outcomes:
Student will get a deep understanding of the general distribution of the chemical components of the ocean, the cycling of key components, which chemical/biological/geological processes influencing the cycling, and how the cycles are coupled to climate and climate changes, processes that are important for air-sea exchange.

Course Contents:

1. Chemistry of water and sea water
2. Major and minor elements in sea water
3. Composition of sea water
   3.1 Constancy of composition
   3.2 Factors influencing composition of sea water
4. Chemistry of air-sea interface
5. Trace elements and their biological roles.
6. Nutrients in the sea
   6.1 Nitrogen
   6.2 Phosphorous and
   6.3 Silicon cycles
7. Dissolved gasses in sea water
8. The carbon dioxide & carbonates system
9. Solubility of salts in seawater
10. The oxidation-reduction potential of seawater. (pH, Eh, etc.)
11. Inorganic agencies effecting the composition of sea water
12. Biological and chemical aspects of dissolved organic material in sea water
13. Radioactive and stable isotopes
14. Marine natural product chemistry
15. Basic idea about chromatography
16. Theory and principle of TLC, GLC, HPLC column
17. Preparation of artificial sea water
18. Chemical features of Indian Ocean and Bay of Bengal
19. Greenhouse gases and its effects in the Bay of Bengal

OCN 2202 Chemical Oceanography Practical 1 CH

Scope and Objectives:
The course cover practical quantitative and analytical processs in marine chemistry.

Learning Outcomes:
Students will be able to analyze the composition of seawater and determine amount of various substances dissolved in seawater. Student will get practical knowledge on the influences of different chemical parameters on the oceanic system.
Course Contents:

1. Volumetric analysis

1.1 Acid base titrations
1.2 Oxidation Reduction titrations

2. Precipitation titrations
3. Preparation of standard for sea water
4. Determination of pH, Eh, minor, trace and major elements of sea water and sediments

5. Determination of Carbonates, bicarbonates and hydrocarbon
6. Determination of Nitrate, phosphate and silicate etc.

Recommended Books

1. Marine Chemistry, by Martin.
2. Chemical Oceanography, by Horne.
3. Chemistry and fertility of sea water, by Harvey.
4. Aquatic Environmental Chemistry, by Haward
5. The Oceans, by HU Svedrup, MW Johnson and RH Flemming. Prentice-Hall, 1942.
6. General Oceanography: An Introduction (Second English Edition), by Dietrich, Kalle, Krauss and Siedler, John Wiley & Sons. 626pp. 1980.

OCN 2203 Marine Microbiology 3 CH

Scope and Objectives:
Marine Microbiology cover different aspects of marine microbial community and their ecosystem. It includes morphology, ecology, physiology of microorganisms and their role in different oceanic processes and economic applications.

Learning Outcomes:
Students will get an overview of marine microbial community and their role in ecosystem services and economic importance.

Course Contents:

1. General concepts and historical development of Marine Microbiology
2. Morphology, structure Systematic study of bacteria, virus, yeasts and fungi
3. Marine microbial ecology: effects of the environment upon microbes - Temperature, Pressure, Radiation, Moisture, Hydrogen ion concentration, Oxidation and reduction potentials, Salinity and Gases
4. Physiology of Microorganisms: Respiration, Nutrition, Fermentation, Product on of enzymes-their nature & enzymatic reactions, Staining properties of bacterial cell, Bacterial spores, Reproduction and life cycle
5. Role of Microorganisms in the transformation of different matters, oils and gases in the sea and associated nutrient cycle, carbon cycle and sulpher cycle.
6. Relationships and differences between marine and terrestrial microorganisms; Deep sea and hydrothermal vents, microbial toxins, food poisoning
7. Microbial pollution of the marine environment (soil, water and live organisms)
8. Economic importance and application of micro-organisms in Oceanography

OCN 2204 Marine Microbiology Practical 1 CH

Scope and Objectives:
Marine microbiology practical course cover different aspects of marine microbial community and their ecosystem. It includes morphology, ecology, physiology of microorganisms and their role in different oceanic processes and economic applications.

Learning Outcomes:

Students will be able to identify marine micro-organisms, prepare different types of culture media and culture microbes, conduct quantitative and quanlitative study of micro-organisms from water, Soil, Fish, Shrimp and other organisms.

Course Contents:

1. Perpetration of different types of culture media
2. Techniques of isolation and identification of marine micro-organisms
3. Quantitative and quantitative study of micro-organisms from water, Soil, Fish, Shrimp, and other fisheries organisms
4. Growth study: factors affecting the growth of micro-organisms, Temperature, Salinity, Osmotic pressure, pH.
5. Culture techniques of marine micro-organisms.

Recommended books:

1. Marine microbial ecology, by EJF Wood, 1965
2. Microbiology, by Nester et al, 1973
3. The microbial world, by Stanier et al, 1970
4. Microbial interactions, edited by JL Reissig, 1977
5. Microbiology, by Michael et al, 1986
6. Marine Microbiology, by B. Austin 1988

OCN 2205 Coastal Morphology and Estuarine Processes 3 CH

Scope and Objectives:

The course will give an understanding of estuarine and coastal environments and the processes responsible for shaping the morphology of estuaries and coasts. It includes shores and shore process, geomorphology and evolution of the Bangladesh coasts, beach configuration and stability, sea level changes and related coastal response, aspects of tides, waves, rip currents, longshore currents, sedimentation and coastal processes, productivity of estuarine ecosystem and anthropogenic interference in coastal processes.

Learning Outcomes:

Students will get an overview of estuarine and coastal ecosystem and the dynamics shaping the morphology of estuaries and coasts.

Course Contents:

1. Shores and shore process: Sea coasts and their origin, classification of sea coasts and shorelines; depositional landforms and others processes of coastal land forms.
2. Geomorphology and evolution of the Bangladesh coasts
3. Beach configuration and stability
4. Sources of beach materials and their related factors
5. Sea level changes and their related coastal response
6. Theory, types and nature of tides in the different coastal area of the world
7. Waves generation, types and their measurements
8. Wave energy density, wave energy flux, wave refraction, wave breaking and wave run-up
9. Rip currents, longshore currents and transport along the coast
10. Sediment cycles and movements in coastal waters.
11. Estuarine sedimentation and coastal processes.
12. Human Interference in Coastal Processes.

13. Upwelling and productivity of estuarine ecosystem

OCN 2206 Coastal Morphology and Processes Practical 1 CH

Scope and Objectives:
The course will give practical understanding of estuarine and coastal environments and the processes responsible for shaping the morphology of estuaries and coasts.
Learning Outcomes:
Students will get field knowledge of estuarine and coastal ecosystem and the dynamics shaping the morphology of estuaries and coasts.

Course Contents:
1. Sea level determination
2. Determination of the rate of sedimentation
3. Waves, tides and current velocity determination
4. Preparation and interpretation of coastal sediment maps and triangle coordinate diagrams from analytical data
5. Observation of shore and shore line protecting processes used in the Bangladesh coast

Recommended Books
1. Coastal Hydraulics, A.M. Mouir.
2. The earth and its ocean, A.C. Duxbury.
3. Principles of Physical Oceanography, by G Neuman, Prentice-Hall.
4. Elements of Physical Oceanography, by HJ McLellan, Pergamon Press. 151pp. 1968

OCN 2207 Oil, gas and renewable energy 3 CH

Scope and Objectives:
This course deals with different forms of renewable energy systems.

Learning Outcomes:
Students will get an overview on renewable energy system considering climate change.

Course Contents:
1. Introduction: Introducing Renewable energy system; energy ecology and environment, Fossil fuels and climate change, energy in a sustainable future. Present solution of global energy problem and understanding of Bangladesh's present needs of energy analysis and economic aspects.
2. Solar radiation: availability, estimation and measurement; global, diffuse and beam radiation, pyranometry and Pyrheliometry, monsoon and other effect on solar radiation.
3. Hydropower: a brief history of water power; types of hydroelectric plant, the Francis turbine, Propellers small scale hydropower and its present and prospects on the world. Kapti Hydropower in Bangladesh.
4. Wind energy: Introduction, estimation wind speed characteristics of the site, relative wind speed. Wind turbine types – horizontal and vertical and environmental impact. Wind energy plant in Kutubdia and Mohuri river dam area.
5. Bioenergy: Biofuels and biogas. Renew ability origin and sustainability of the photosynthetic process. Energy swimming, the sources of bio energy, bio mass

based system power. Energy from waste material, energy from phytoplankton, energy from seaweeds and energy from nypa sap.

6. Geothermal energy: geophysical and geological process, geothermal exploration, drilling and fluid extraction, Utilization of geothermal energy, tsunami and its present status.
7. Tidal energy: Energy from the ocean, tidal power plants, Electricity generation from tidal wave, economics of tidal energy, tidal power plant around the world. Environmental impact and future of tidal power.

Recommended Books

1. Solar Energy utilization – G.D. Rai.
2. An introduction to solar Energy for scientists and Engineers – S. Wieder.
3. Tidal Energy – R. H. Charlier.

OCN 2209 Marine Biochemistry 3 CH

Scope and Objectives:
This course is designed aiming to understand the general biochemistry and physiology of marine organisms. It will also includes different aspects of thermal Strategies in the marine environment, marine bio-mineralization and biodiesels.

Learning Outcomes:
Student will be able to understand the general biochemistry and physiology of different marine organisms and aspects of bio-mineralization and biodiesels.

Course Contents:

1. Introduction (Important definition of Marine Biochemistry).
2. Metabolism of marine organisms.
3. Anaerobiosis of marine organisms.
4. ATPases, Carbonic Anhydrases, pH regulation.
5. Thermal Strategies in the Marine Environment.
6. Corals: Symbiosis, calcification, pH regulation, nitrogen, metabolism, in vitro research approaches, bleaching.
7. Osmoregulation and acid/base regulation in hagfish, shark and Bony fishes.
8. Introduction to Marine Bio-mineralization.
9. Marine Biomineralization: Silica, Calcium carbonate, and Bone formation.
10. Biodiesels.

OCN 2210 Marine Biochemistry Practical 1 CH

Scope and Objectives:
This course is designed to give a practical knowledge of differnt qualitative and quantiative analytical methods of biochemistry and physiology of marine organisms.

Learning Outcomes:
Having successfully completed this course student will be able to identify and separate differnt biomolecules like amino acids, proteins, carbohydrates, lipids and vitamins etc. in marine organisms.

Course Contents:

1. Identification of biomolecules - Amino acids, proteins, carbohydrates, lipids.
2. Estimation of the strength of amino acid using formal titration
3. Separation of amino acids using paper chromatograph
4. Separation of amino acids using thin layer chromatography (TLC)
5. Estimation of proteins using Folin Ciocalteu (Lowry) method.
6. Estimation of Vitamin-C using 2,6-dichlorophenol indophenol

Recommended Books:

1. Fox, Denis L. "Perspectives in marine biochemistry." *Annals of the New York Academy of Sciences* 90.3 (1960): 617-621.
2. Stewart, W. D. P. (1974). *Algal physiology and biochemistry* (Vol. 10). Univ of California Press.
3. Church, T. M. (Ed.). (1975). *Marine chemistry in the coastal environment*. Washington, DC: American Chemical Society.
4. Kittredge, J. S. (1974). Comparative biochemistry: Marine biochemistry. In *Experimental Marine Biology* (pp. 225-267). Academic Press Los Angeles, California.
5. An Introduction to Practical Biochemistry – David T Plummer
6. Introductory Practical Biochemistry – Sawhney & Singh

OCN 2212	**Viva Voce**	**2 CH**

First Semester	3rd Year	
Course Code	**Course title**	**CH**
OCN 3101	Geological Oceanography	3
OCN 3102	Geological Oceanography Practical	1
OCN 3103	Fisheries Oceanography	
OCN 3104	Fisheries Oceanography Practical	1
OCN 3105	Marine Plankton	3
OCN 3106	Marine Plankton Practical	1
OCN 3107	Law of the Sea	3
OCN 3109	Marine Pollution and EIA	3
OCN 3110	Marine Pollution and EIA practical	1
OCN 3112	Field Trip	1
	Total	**20**

Second Semester	3rd year	
Course Code	**Course title**	**CH**
OCN 3201	Hydrology and Fluid Dynamics	3
OCN 3203	Marine Biotechnology	3
OCN 3204	Marine Biotechnology Practical	1
OCN 3205	Remote Sensing and GIS	3
OCN 3206	Remote Sensing and GIS Practical	1
OCN 3207	Paleoceanography	3
OCN 3208	Paleoceanography Practical	1
OCN 3209	Oceanography of the Bay of Bengal	3
OCN 3202	Viva Voce	2
	Total	**20**

Third Year
Semester I

OCN 3101 Geological Oceanography 3 CH

Scope and objectives:
The course will give an understanding about history of marine geology, geological and physiographic features of the earth. Acquire knowledge about the sea floor spreading, development and evidences. The physiographic features of the ocean will be studied.

Learning Outcomes:
Students will get an idea about different features of geological oceanography including formation of sea floor.

Course Contents:

1. Brief history of marine Geology and geological time scale
2. Early mapping, positioning and sampling techniques, General Geological and physiographic features of the Earth
3. Shape and dimension: hypsometry, relative distribution of land and sea

4. Continental drift and sea floor spreading: conceptual development, evidences, opposition
5. Tectonics as an explanation of major Earth features and processes
6. Physiographic features of the Ocean and Ocean basins
7. Large scale features: ridge, trench, fracture zone, fault, sea mount, island arc, aseismic ridge, abyssal hill, guyot, abyssal plain and others
8. Features associated with continental margin: terrace, shelf, slope, rise, depressions and others
9. Near shore and other features: Reef, coral island, atoll, sedimentary formations and others
10. Eustatic changes of sea level, causes and methods of study (Tsunamis, turbidity currents).
11. Earthquakes, volcanism and mountain building in the sea
12. Evolution of the Indian Ocean floor.
13. Topography and sediments of the floor of the Bay of Bengal
14. Deep sea deposits: brown clay, manganese nodule and oozes, Calcium carbonate and foraminifera deposition in the sea.

OCN 3102 Geological Oceanography Practical 1 CH

Scope and objectives:
This practical course is designed to understand and practice the theoretical knowledge intensively. This course includes field trips to sea, collect water and sediment samples and analysis in laboratory.

Learning Outcomes:
The students will able to prepare different types of maps, charts and analysis the deep sea sediment from this practical course.

Course Contents:
1. Preparation of bathymetric charts and interpretation
2. Collection, separation and identification of heavy minerals
3. Deep sea sediment analyses, manganese nodule and foraminifer's collection and identification.
4. Preparation and interpretation of sediment maps and triangle coordinate diagram from analytical data.

Recommended Books
1. Marine Geology, P. H. Kuenen.
2. Submarine Geology, P.P. Shepard.
3 Marine Geology, J. Kennat
4. Sea level, Land Levels and tide ganges, Emery and Aubrey.

OCN 3103 Fisheries Oceanography 3 CH

Scope and Objectives:
The Fisheries oceanography course covers the evolution, population, biology, geographical distribution and economical value of marine fisheries. This course provides knowledge about classification of marine fishes and shellfish, the fisheries ecosystem and climate variability. There is a scope of learning about the fishing grounds of Bay of Bengal.

Learning Outcomes:
The students will get a deep idea about biology of different fishes and other marine organisms. This course will able to help students to know about Bay of Bengal details.

Course Contents:

1. Systematics of fish and shellfish: Classification of marine fishes and shellfish of Bangladesh
2. Life history, reproduction, food & feeding mechanisms, migration and distribution of commercial fisheries organisms of the Bay of Bengal
3. Fishing grounds of the Bay of Bengal; exploratory & commercial fishing in marine waters of Bangladesh.
4. Fishing crafts and gears used in the Bay of Bengal: Types, design, operating techniques and gear selectivity and no fishing zones for different fisheries.
5. Fish population and their dynamics: Effort and catch; study of growth rates; age determination; mortality and over fishing.
6. Fishing forecasting: Fish school front, ecological selectivity and potential fishing zone detection.
7. Fisheries monitoring: Concept of common properties, GPS data logger and fishing pause.
8. Climate resilience fisheries: Global climate change, climate and the geography of the sea; decadal oscillations in the Bay of Bengal: Hilsa, Sharks and Tuna fish.
9. FAO code of conduct for responsible fisheries and Marine fisheries ordinance of Bangladesh.

OCN 3104 Fisheries Oceanography Practical 1 CH

Scope and Objectives:
The course will improve student's skill to identify fishes and fisheries activities in BoB.

Learning Outcomes:
The students will be able to identify fishes, crustecians, molluscs etc. in pelagic and demersal environment of ocean. Different fishing crafts and gears used in BoB. Students will also get knowledge on breeding, growth and other dynamic and stock parameters of marine fishes.

Course Contents:

1. Identification of fishes, crustaceans and mollusc
2. Biometric study of fishes and prawns.
3. Gut content analysis, age determination, maturity determination of reproductive organs.
4. Observation of different types of crafts and gears used in the Bay of Bengal
5. Determination of growth rates, mortality and overfishing.
6. Detection of fishing and no fishing zone for commercial fisheries.

Recommended Books

1. Fisheries Biology, Assessment and Management, M. King
2. An Introduction to the Practice of Fishery Science, W. F. Royce
3. Bangladesh Fisheries, M. Shafi.

OCN 3105 Marine Plankton 3 CH

Scope and objectives:
The course provides knowledge about the classification and importance of marine planktons. There is a huge scope of understanding the distribution of planktons and its relationship with seasonality, learning about different culture techniques, knowing about migration and productivity of plankton.

Learning Outcomes:
The students will gather knowledge about marine planktons and culture techniques of commercial species. The Bangladesh coastal plankton species are also known by the students from this course.

Course Contents:

1. Definition, classification and importance of marine plankton
2. Phytoplankton
   - 2.1 Definition, Classification, morphology and physiology
   - 2.2 Factors affecting the growth, distribution and seasonal succession of Phytoplankton in different Oceans.
   - 2.3 Productivity and their measurement (Lake, Estuary, Oceans)
   - 2.4 Factors affecting primary production of the sea, nutrients, light, temperature, micronutrients, grazing etc.
   - 2.5 Seasonal & non-seasonal blooms, causes of phytoplankton bloom, the problem of single species bloom
   - 2.6 Culture techniques of phytoplankton *Skeletonema costatum*, *Chlorella* and *Tetraselmis*
3. Zooplankton
   - 3.1 Definition and classification of zooplankton
   - 3.2 Factors affecting the growth, distribution and seasonal changes of zooplankton
   - 3.3 Seasonal changes and breeding of zooplankton
   - 3.4 Geographical distribution of zooplankton
   - 3.5 Vertical distribution and migration of Zooplankton
   - 3.6 Food and feeding habit of zooplankton
   - 3.7 Culture techniques of commercially important zooplankters - Artemia, Rotifer, Copepod
4. Phytoplankton-zooplankton relationship
5. Fish-plankton relationship
6. Plankton collecting gears
7. Determination of plankton biomass, occurrence, abundance, species richness
8. Plankton of the coastal waters of Bangladesh

Recommended books:

1. Plankton and productivity in the oceans, by JEG Raymount, 1963
2. Primary productivity in aquatic environment, edited by CR Goldman, 1974
3. Nature adrift: The story of marine plankton, by J Fraser, 1962
4. The marine and freshwater plankton, by CC Davis, 1955
5. Marine plankton, by Newell and Newell, 1977
6. Zoogeography and diversity in plankton, by Spoel et at, 1979

OCN 3106	Marine Plankton Practical	1 CH

Scope and Objectives:
This course is aimed to gather practical knowledge on field about preparation and handling of plankton collection equipment. The course is designed to determine productivity and salinity tolerance of plankton for understanding culture techniques.

Learning Outcomes:
The students will able to know details about marine phytoplankton. The different approaches of planktology will be understood.

Course Contents:

1. Preparation and handling of plankton collection equipment.
2. Collection, preservation, identification and estimation of plankton.
3. Laboratory and mass culture of Phyto/zooplankton.
4. Preparation of plankton slides.
5. Determination of productivity.
6. Determination of Zooplankton Biomass.
7. Salinity tolerance of plankton.

OCN 3107	Law of the Sea	3 CH

Scope and opportunities:
The course is designed to learn the basic concept of the Law of the Sea. There is an opportunity to study maritime boundaries particularly different types of territories in sea and know the functional marine zones and legal implications of EEZ.

Learning Outcomes:
Students will able to know the maritime territories. The different functions of marine zones of BoB will be studied by the students.

Course Contents:

1. Introduction to the Law of the Sea: Concept, Evolution, U.N. Conferences and Conventions: History of the law of the sea, Concept and evolution of the law of the sea, The United Nations Conferences and Conventions, UNCLOS, The U.N. Law of the Sea Convention 1982.
2. Maritime Territory: The legal regime of the internal waters and of the territorial waters, straight base lines, Bays, Bays bordered by more than one state, Internal waters, Jurisdiction in internal waters, The Bangladesh/Myanmar maritime dispute, India-Bangladesh Maritime dispute, Implications of the judgment of the ITLOS on maritime boundary between a) Bangladesh and Myanmar; b) Bangladesh and India
3. Territorial Sea: The competences of the coastal State, Innocent passage, Competences of the coastal State concerning fisheries, Competences concerning security and defense, Competences concerning customs and fiscal regulations, Competences concerning navigation, Competences concerning the exploration and exploitation of the seabed and its subsoil
4. Functional Marine Zones: The contiguous zone, Other functional marine zones, Fishery zones
5. EEZ and its legal implications,

6. The Legal regime of the continental shelf,
7. The legal regime of the Deep-sea bed.
8. The Legal regime of the high seas.
9. International Law of Fisheries
10. Marine Pollution Legal Regulation.
11. Marine Scientific Research: Legal problems and Solution

Recommended Books

1. Hand book on Marine Pollution, Edgargold.
2. The Law of the sea, R. R. Churchill and A. V. Lowe.

OCN 3109	**Marine Pollution and EIA**	**3 CH**

Scope and objectives:
This course provides knowledge about characterization of pollutants on the marine environment by different physiochemical and biological tests. Students will learn the determination techniques of some trace elements, lethal concentrations etc in oceanic environment.

Learning Outcomes:
The students will get a deep understanding about marine pollution and control. Different types of controlling methods of marine pollution as well as management practicies will be taught by this course.

Course Contents:
Marine Pollution

1. Introduction
   1.1 Definition of pollution, types, contamination and sources of air pollution, water pollution, coastal and deep-sea pollution, effect of pollutants on organism
2. Water Pollution
   2.1 Types, sources and consequences of water pollution. Ecological and biological aspects of water pollution. Types and characteristics of domestic, industrial and agricultural waste and their effects on water bodies
3. Sewage
   3.1 Definition of sewage, sources and types of sewage, Characteristics of sewage, Sewage treatment, Eutrophication and its effect. Solid waste disposal problem and its management in urban area
4. Industrial Wastes
   4.1 Sources of effluents, nature of effluents of some industries, Effects of effluents on aquatic ecosystem, Waste treatment: Primary treatment, Secondary treatment and Tertiary treatment
5. Heavy Metals
   5.1 Introduction, Sources of heavy metals, Effects of heavy metals on aquatic ecosystem. Bioaccumulation and biomagnification of lead, cadmium, chromium & mercury
6. Agro-Chemicals
   6.1 Introduction, types of agrochemicals, Uses of Agrochemicals, Effects of agrochemicals on biota, Bio-accumulation and biomagnification of

organochlorine pesticides (DDTs) in food chain and its impact on leaving ecosystem

7. Oil Pollution
   7.1 Definition of oil, types of hydrocarbon, sources of hydrocarbon, fate of oil on the surface water of the ocean, impact of oil on marine ecosystem, Removal technique of oil from surface water of the ocean
8. Toxicology
   8.1 Introduction, principles and concepts, classification and sources of toxic substances. Pathways of toxic substances into ecosystem. Effect of toxic substances – emphasis on physiological effects

Environmental Impact Assessment

9. Introduction: History of EIA, Definition of Environmental Impact Assessment
10. Major issues of the EIA process
11. Methodological aspect of EIA
    11.1 Preliminary activities
    11.2 Scoping methods in EIA
    11.3 Baseline studies in EIA Process
12. The EIA process adopted in Asia and the pacific region
13. EIA and international/bilateral development and donor agencies
14. EIA study in development projects
15. Major development activities
    15.1 Flood protection embankment
    15.2 Coastal aquaculture developments
    15.3 Solid waste disposal areas
    15.4 Green-house gases
    15.5 Industrial impacts
    15.6 Health impacts (Risk assessment)
    15.7 Impact of Farakka-Barrage on coastal region of Bangladesh
    15.8 Guidelines of developing countries

OCN 3110	**Marine Pollution and EIA Practical**	**1 CH**

Scope and Objectives:
This course will provide the practical knowledge on different ocenic parameters determining marine pollution as well as monitoring and management practices.

Learning Objectives:
The students will able to analysis water quality by using instruments and labortories. They will gather knowledge about marine pollution and know how to avoid pollution.

Course Contents:

1. Assessment of Physio-chemical condition: DO, BOD_5, COD, pH, S‰. Nutrients, Organic matter
2. Spectrophotometric analysis of organic and inorganic matters in water
3. Physicochemical & Biological test of water quality
4. Determination of some trace elements
5. Comparative study of organisms between polluted and unpolluted areas
6. Determination of Lethal Concentration/Dosage (LC_{50}/LD_{50})

7. Marine activities (coastal deforestation, shrimp farming)/ Industrial/ health impacts (Risk assessment).

Recommended readings

1. Global Air Pollution, by H Bridgman. John Wilay & Sons, 1990.
2. Principles of Air Pollution Methodology, by T Lyons and B Scott.CBS Pub. & Distributions, New Delhi, 1992.
3. Atmospheric Chemistry & Physics, by JH Seinfild.John Wiley & Sons. 1998.
4. Environmental Water Pollution and Control. Anmol Pub. New Delhi
5. Water Pollution, by AK Tripallhi, Astish Pub. New Delhi. 1990.
6. Assessment of Water Pollution, by SR Mishra. APH Pub. New Delhi. 1996.
7. Environmental Impact Assessment (EIA), by C Wood, Longman, 1995.
8. Introduction to Environmental Impact Assessment, by J Glassman, R Therive and A Chadwick. UCL Pren. 1998.
9. Environmental Impact Assessment (EIA), by P Walherdn. Mc-Graw Hill Co. 1996

OCN 3112	**Field Trip**	**1 CH**

Third Year
Semester II

OCN 3201	**Hydrology and Fluid dynamics**	**3 CH**

Scope and Objectives:
The course will give an understanding of the processes of hydrology and fluid dynamics of coastal and marine environment. It includes hydrologic cycle, hydrologic system model, the physics and hydrodynamics of different fluids.

Learning Outcomes:
Students will get knowledge on the processes and dynamics of hydrology and differnt fluids of coastal and marine environment.

Course Contents:

1. Definition and introduction to Hydrology: Hydrology cycle, Hydrologic system model, Hydrologic model classification, the development of Hydrology.
2. Hydrologic process: Continuity equation, discrete time continuity, porous medium flow, water balances.
3. Precipitation
4. Evaporation and transpiration.
5. The physics of the fluids:
   5.1 Fluid properties, fluid statics, pressure variations, hydrostatic force (curve & plane surface), buoyancy.
6. Hydrodynamics:
   6.1 Types of flow, continuity equation, equation of motion, momentum equation, real fluid flow, energy losses.
7. Open channel flows:
   7.1 Type of channel: non-uniform flow, gradually varied flow, unsteady non-uniform flow.
   7.2 Steady uniform flow, boundary layer and boundary roughness, velocity distribution, bed shears and shear velocity.

7.3 Secondary flow, resistance equation.

Recommended Books

1. Acheson, D.J. (1992) Elementary Fluid Dynamics. Oxford University Press. ISBN 019 859 6790.
2. Shyy, W & R Narayanan (1999) Fluid Dynamics at Interfaces. Cambridge University Press.
3. Mayele R (2000) Principle of Fluid flow and Sediment Transport. CRT Press, Frankfort, Germany.
4. Fallavotti, G (2002) Foundations of Fluid Dynamics. Springer Publications.

OCN 3203	**Marine Biotechnology**	**3 CH**

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

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

Course Contents:

1. General Introduction and scope of biotechnology and its branches. Role of biotechnology in human life.
2. DNA Technology: Basic strategy of gene manipulation and analysis of marine organisms. Application of DNA technology. Gene, growth and others, transformation among animals. Transgenic fishes.
3. Biosensors: Recent developments in biosensors and their uses. Characteristics of biosensors. Biochemical application of biosensors in environmental and clinical pollution detection.
4. Biotechnology in pollution control: Introduction to pollution of the sea. Use of commercial blend of microorganisms and enzymes in wastewater treatment. Immobilize cells in waste treatment. Potential application of recombinant DNA technology in waste treatment.
5. Protein biotechnology: Industrially significant proteins and their sources, microorganisms, plants and animal tissues. Proteins employed in health care industry. Recombinant protein technology.
6. Enzyme biotechnology: Introduction to enzymes and theirs uses in medical, chemical and food industry, leather industry, detergents, textile, paper industry, antibiotics, biocatalysts and fermentation process. Industrial approach to enzyme production, extraction of natural products, detoxifying agents.

OCN 3204	**Marine Biotechnology Practical**	**1 CH**

Scope and Objectives:
This practical course is designed to do DNA isolation, extraction and estimation very intensively by the students.

Learning Outcomes:
Students will be able to handle molecular technology sensitively and carefully. They will be able to do DNA analysis and gel electrophoresis independently.

Course contents:

1. DNA Isolation and Extraction, PCR amplification
2. Estimation of DNA
3. Determination of purity of DNA
4. Gel electrophoresis of bacterial genomic and plasmid DNA
5. Transformation with plasmid DNA
6. Use of commercial blend of microorganisms and enzymes in wastewater treatment

Recommended Books

1. Glazer, AN and Nikaido, H Microbial Biotechnology
2. Maier RM pepper, IL and Gerba, CP environmental Microbiology
3. Atlas, RMA and Bartha, R Microbial Ecology
4. Frank, F Protein Biotechnology
5. Walsh, G and Headon, D Protein Biotechnology
6. Bohak, Z and Sharon, N Biotechnological applications of proteins and enzymes

OCN 3205 Remote Sensing and GIS 3 CH

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 is discussed in this course.

Learning and Outcomes:
Students will learn about GIS data structure and GIS specific raster/grid manipulation, map reading, output, water quality mapping and modeling, monitoring sea surface temperature, oil spills and biodiversity mapping.

Course contents:

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
   - 3.7 Changes in coastline and bathymetry
   - 3.8 Water quality mapping and modeling
   - 3.9 Monitoring Sea Surface Temperature (SST)
   - 3.10 Monitoring Oil Spills
4. Land use change detection

5.Biodiversity mapping

GIS

1. Introduction to marine 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)
   - 1.6 GIS theories
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

OCN 3206 Remote Sensing and GIS Practical 1 CH

Scope and Objectives:

This course will provide different types of mapping practices, training on remote sensing and the use of different types of instruments for GIS application.

Learning Outcomes:

Students will able to use remote sensing and GIS instruments independently. They will also gather knowledge about various types of data processing and managing.

Course Contents:

Remote Sensing

1. Image file/format manipulation
2. Radiometric correction practices
3. Geometric correction practices
4. Unsupervised Classification practices

5. Training and Supervised Classification practices
6. Post-processing practices
7. Output and mapping practices
8. GIS analyses of post-processing RS data
9. Case studies (about 50% of the lab sessions)

GIS

1. ArcView/TNTLite/GRASS introduction
2. Using raster layers in ArcView/TNT/GRASS
3. Digitizing/Screen Digitizing exercises
4. Raster data processing
5. Vector data processing
6. Georeferencing
7. Attribute/Data manipulation
8. Using Mobile GPS, incorporating data with GIS
9. Case studies (about 50% of the lab sessions)

Recommended Books

1. Remote Sensing and Image Interpretation, 3rd Ed. by TM Lillesand and RW Kieber. John Willey & Sons. 1994
2. Use of high-resolution Satellite data for Coastal Fisheries. RSC Series No.5. Remote Sensing Center, FAO. 1991.
3. Remote Sensing: Models and methods for Image processing, 2nd Ed. by RA Schowengerdt. Academic Press. 1997.
4. Geographic Information Systems: an introduction, by J Star and J Estes. Prentice-Hall, NJ. 303pp. 1990.
5. An Introduction to geographical Information Systems, by I Heywood, S Cornelius and S Carver. Longman. 279pp. 1998.
6. The GIS Book (Third Edition), by GB Korte, P.E. Onward Press. 220pp. 1992.
7. Exploring Geographic Information Systems, by N Chrisman. John Wiley & Sons. 298pp. 1997.
8. Principles of Geographical Information Systems, by PA Burrough and RA McDonnell. Oxford University Press. 333pp. 1998.

OCN 3207 Paleoceanography 3 CH

Scope and objectives:

This course contains basic palaeo-oceanography and characteristics, framework of palaeo-oceanography. Different types of evidences as geomorphological, lithological, biological, chronological evidences in ocean are discussed in this course. Climate change, it's cause and significance, glacial periods, sea-level changes will also discuss in this course.

Learning and Outcomes:

The students will able to know about basic palaeo-oceanography and human evolution, migration.

Course contents:

1. Palaeo-oceanography: meaning, scope, multidisciplinary approach, and importance to study
2. Palaeo-oceanic Environment: its extents, duration, characteristics and framework

3. Geomorphological Evidences: Underwater Landform; Trenches. Terraces, ridges, sea-floor spreads, rift-valley
4. Lithological Evidences: Marine deposits, Facies and Beddings; Palaeosols; and Ice-core stratigraphy:
5. Biological Evidence: Pollen analysis; Diatom analysis; Firaminefera Analysis; Plant and Animal Macrofossils
6. Chronological Evidences: C14 dating; Uranium series dating; Dendrochronology, varve chronology; Oxygen-isotope Stages
7. Marine Oxygen Isotopic Stages: Principles, Calculation, Implication, Land-Ocean interface
8. Climatic changes in the Past: Causes and significance; glacial periods; sea-level changes; human evolution and migration
9. Quaternary Sea-level Change: Causes, extents, rates and directions, Implications
10. Palaeo-Oceanography of Bay of Bengal: Quaternary Lithology. Coastal and Ocean Stratigraphy; Climate change; Palaeo-monsoon, Quaternary sea-level changes; Palaeo-shoreline changes; landforms and correlation, human occupancies

Recommended Books

1. J.J. Lowe and M.J.CV. Walker Reconstructing Quaternary Environment 1997
2. N. Robert The Holocene; An environmental History 1989
3. M.H. Monsur, 1995. An Introduction to the Quaternary Geology of Bangladesh.
4. M. Shahidul Islam (2001) Sea-Level Changes of Bangladesh: Last Ten Thousand years: Asiatic Society of Bangladesh.

OCN 3208 Paleoceanography Practical 1 CH

Scope and Objectives:
This practical course provides scope of learning basic paleoceanography by practicing macro and micro fossil analysis.

Learning Outcomes:
The students will gather intensive experience on macro and microfossils.

Course Contents:

1. Study of Macrofossil: Wood, Bones, Pottery and Artifacts
2. Study of Microfossils: Pollen Analysis, Diatom Analysis: Principle and Foraminifera Analysis3.
3. Study of Oxygen Isotopes, isotopic composition of seawater, calculation of marine oxygen isotopic stages
4. Radiometric dating, principles and procedure of C14 dating.

OCN 3209 Oceanography of the Bay of Bengal 3 CH

Scope and objectives:
This course is designed to gather knowledge about physical, chemical, biological, geological oceanography of Bay of Bengal. This course aimed to provide learning on resources, geopolitics and trades of Bay of Bengal.

Learning Outcomes:
The students will know about seasons and natural calamities in Bay of Bengal and Indian Ocean. The comparative study between Bay of Bengal and other seas is also an important outcome of this

Course contents:
1. Introduction: Location, boundary, historical perspective, human occupancy
2. Physical Oceanography of the Bay of Bengal: Continental shelf; Ocean dynamics: temperature, salinity, density, tide, wave, current, sediment transport, MLD
3. Chemical Oceanography of the Bay of Bengal: Water chemistry, sediment chemistry, Nutrients dynamics, Bio-geo chemistry
4. Biological Oceanography of the Bay of Bengal: Chlorophyll concentration, primary production, plankton, fish, mollusk, tropic relationship
5. Geological Oceanography of the Bay of Bengal: Sediment types, bathymetry, slope, plate and active boundaries, major features
6. Monsoon and climate system in Indian Ocean
7. Natural calamities in the Bay of Bengal and Indian Ocean
8. Oceanographic studies of Islands in the BOB: St. Martin, Sonadia and Nijhum Dweep.
9. Comparative studies between Bay of Bengal and Arabian Sea

Recommended Books
1. Regional Oceanography by M. Tomszack
2. Marine Geology by Erickson and Timothy

OCN 3202	**Viva Voce**	**2 CH**

First Semester	4th Year	
Course Code	**Course title**	**CH**
OCN 4101	Hydrography	3
OCN 4102	Hydrography Practical	1
OCN 4103	Marine Natural Products	3
OCN 4104	Marine Natural Products Practical	1
OCN 4105	Blue Economy and Sustainable Development	3
OCN 4107	Seamanship and Maritime Navigation	3
OCN 4108	Seamanship and Maritime Navigation Practical	1
OCN 4109	Ocean Forecasting and Meteorology	3
OCN 4110	Ocean Forecasting and Meteorology Practical	1
OCN 4111	Research Methodology	3
OCN 4112	Field Trip	1
	Total	**23**

Second Semester	4th Year	
Course Code	**Course title**	**CH**
OCN 4201	Port and Shipping Management	3
OCN 4203	Marine Biodiversity and Conservation	3
OCN 4205	Ocean Modelling	3
OCN 4206	Ocean Modelling Practical	1
OCN 4207	Integrated Coastal Zone Management	3
OCN 4209	Seafloor Exploration and Seismology	3
OCN 4211	Research Project	6
OCN 4202	Viva Voce	2
	Total	**24**

Forth Year
Semester I

OCN 4101	**Hydrography**	**3 CH**

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:
The students will learn about different hydrographic survey methods, data collection and processing.

Course contents:

1. Brief history of hydrography, importance of hydrography, fields of competence associated with hydrography
2. Principles of hydrographic surveying: Survey specification and planning, data gathering, processing, analysis, quality and etc

3. Positioning: The earth, datum, coordinates systems, principles of cartography and projections; positioning methods (GNSS, electromagnetic, acoustic and optical techniques).
4. Horizontal and vertical control methods of hydrography
5. Instruments used to establish horizontal and vertical control
6. Depth determination: Acoustic and Motion sensors, Transducers, Acoustic systems and non- acoustic systems
7. Seafloor classification and feature detection: Seafloor feature detection, seafloor characterization
8. Water levels and flow: Tides and water levels and flow, water level flow and tidal currents
9. Topographic surveying: Topography, coastline delineation and navigation positioning, Remote sensing tools used for topographic surveying and cartography
10. Hydrographic practice: Hydrographic survey planning, survey reconnaissance, data acquisition, coast line delineation and data processing
11. Hydrography of the Bay of Bengal
12. Coastal erosion, artificial nourishment and planning of coast protection.
13. Coastal and offshore engineering processes and problems
14. Sea-walls, break-water, jetties and groins
15. Coastal protection processes from hydrographic movements

OCN 4102	**Hydrography Practical**	**1 CH**

Scope and Objectives:
The course is designed aiming to give an exclusive practical and hands on experience on the various aspects of coastal and marine hydrography.

Learning Outcomes:
Student will be able to collect, record and analyze the hydrographic data using appropriate techniques in the field and laboratory to prepare of hydrographic charts and interpretation.

Course Contents:
1. Collecting, recording and analyzing the hydrographic data using appropriate techniques in the field and laboratory.
2. Preparation of hydrographic charts and interpretation.
3. Prediction of tide, current measurement including wave

OCN 4103	**Marine Natural Product**	**3 CH**

Scope and objectives:
The course contains basic natural products, their classification, isolation techniques. This course provides opportunity to know importance of marine natural products.

Learning outcomes:
Students will learn about marine natural products, toxin types and utilization in supporting blue economy. The students will also know about marine pollution control.

Course contents:

1. Introduction to natural product chemistry; classification of natural products, isolation techniques and physiochemical data, the acetate pathway (fatty acids and polyketides), the shikimate pathway (aromatic amino acids and phenylpropanoids), the mevalonate (terpenoid and steroids), alkaloids, peptides and amino acid derivatives, and carbohydrates
2. Significance of marine natural products. Isolation techniques: liquid-liquid extraction, membrane separation methods, Chromatography (paper, TLC, HPLC) techniques. Characterization techniques: IR, UV, NMR and Massspectra,
3. Types of important products: Antibiotic, anti-tumour, tumour-promotor, anti-inflammatory, analgesic, cytotoxic, anti-viral anti-fouling compounds of marine origin.
4. Marine toxins: Saxitoxin, brevitoxin and ciguatoxin, Marine peptides & alkaloids: pyridoacridine, pyrrolocridine indole, pyrrole, isoquinoline alkaloids.
5. Marine prostaglandins and marine cosmetic products. Theories of drug action and factors affecting drug action.
6. Biotechnology applications in Aquaculture: chromosomal manipulations: Gynogenesis, androgenesis, polyploidy and transgenesis
7. Role of biotechnology in marine pollution control.

OCN 4104 Marine Natural Product Practical 1 CH

Scope and Objectives:
The course is designed aiming to give a practical overview of marine natural products.

Learning Outcomes:
Student will be able to isolate and extract marine natural product using different methods and techniques.

Course Contents:
1. Isolation technique: liquid-liquid extraction, membrane separation methods, Chromatography (paper, TLC, HPLC) techniques.
2. Characterization techniques of IR, UV, NMR and Mass spectra.

OCN 4105 Blue economy and sustainable development 3 CH

Scope and objectives:
The course contains study and basic concepts of blue economy component and sustainable development framework.

Learning outcomes:
The students will able to understand blue economy opportunities from this course particularly BoB consideration.

Course contents:
1. Introduction: Blue Economy concept, Blue Planet
2. Principles of blue economy
3. The Blue Economy a Framework for Sustainable Development
4. SIDS and the Blue Economy
5. The Blue Economy Issues
6. Sustainable use of biodiversity

7. Food security
8. Unsustainable Fisheries
9. Climate change and managing carbon budgets- Acidification, Blue Carbon,
10. Marine and coastal tourism
11. Pollution and marine debris
12. Governance and international cooperation
13. The Blue Economy –Opportunities: Shipping and Port Facilities, Fisheries, Tourism
14. Aquaculture, Energy, Biotechnology, Submarine mining
15. Charting a course to the Blue Horizon
16. Preliminary Listing of Potential Partner Agencies and Processes:
17. Key concepts: Concepts of sustainability and Sustainable development, History of sustainability, Sustainability measurement, ecological footprint
18. Sustainable Development Goals (SDGs), Goal 14 of SDGs, Intersect oral linkage, Bangladesh and Sustainable Development Goals

Recommended books
1. The Blue Economy by Gunter Pauli

OCN 4107 Seamanship and Maritime navigation 3 CH

Scope and objectives:
The course is aimed to provide knowledge about basic structure of ship and the navigational instruments. This course has opportunity to know about safety equipment and procedures.

Learning outcomes:
The students will gather knowledge about ship and navigation. They will know the basic operation of navigational instruments in ship during travelling in ocean.

Course contents:
1. General information on Seamanship and Navigation
2. Parts of the ship: Principal dimensions, chamber, bulwark, keel, deck stringer, freeboard, frames, strakes, bilge keel etc.
   Centre of gravity, center of buoyancy, Meta centric height, righting lever, righting moment, stable, unstable and neutral equilibrium, reserve buoyancy, angle of loll, list heel, TPC, FWA etc.
3. Navigational Instruments: Sextant, Peiorus, Azimuth mirror, Magnetic compass, Gyrocompas GPS, Echo sounder, Radar- working principles, care and maintenance
4. LSA and FFA: Life buoy, Life jacket, life raft, class C boat, Rescue boat, EPIRT, SART.
5. Charts, publications and terms: Basic terms, chart overview, Chart datum and depths
6. Buoyage: Lateral buoys and Cardinal buoys
7. Navigation: Plotting a position, measuring distance and bearing, Position fix and Heading
8. Safety: Personal and boat safety equipment, Safety procedures and briefing, Communications, Engine checks and Rescue procedures.
9. Seamanship: Hand lead line, Deep sea line, Anchoring, Rafting, mooring ship handling, duties of watch keeping officer, Dry docking, preparation for voyage, painting schedule etc.:

10. Tides: Tidal streams and Tidal height.
11. Electronic Navigation: GPS terms, GPS use and using waypoints.
12. Rules of the Road: Risk of collision and save ways.
13. Pilotage: Harbor information, Transits and Pilotage plan.
14. Passage Planning: SOLAS V requirements, Pre-planning and Chart choice.
15. Fire Fighting: definition of fire, elements of fire, fire triangle, Fire prevision, Fire detection system and alarms, fire extinguishing system and equipment, firefighting methods, firefighting drills.

OCN 4108 Seamanship and Maritime Navigation Practical 1 CH

Scope and Objectives:
The course is designed aiming to give the students an exclusive practical knowledge on the various aspects of seamanship and marine navigation system and processes.

Learning Outcomes:
Student will get hands on experience in boat handling and operation in the sea, use of different instruments required for safe navigation as well as practice of navigation signals and rules.

Course Contents:
1. Boat handling and operation, Anchoring, Rafting and Mooring in the sea
2. Field trip to research vessel.
3. Handling and use of Sextant, Echo sounder, Radar, Gyro compass, Magnetic compass, V.H.F. etc in a ship.
4. Practice of distress signals and rules of navigation.
5. Case study on Seamanship and Navigation processes.

Recommended Books
1. A Manual of Elementary Seamanship, Commander D. Wilson-Barker, R.N.R., 1909, 244 pp.
2. Marine Navigation and Safety of Sea Transportation, by Adam Weintrit, CRC Press, 2009, 794 pp.
3. Illustrated Seamanship, by Ivar Dedekam, Wiley Nautical, 2007, 91 pp.
4. The American Practical Navigator: Bowditch, by Nathaniel Bowditch, 2002, 296 pp.

OCN 4109 Ocean Forecasting and Meteorology 3 CH

Scope and objectives:
The ocean forecasting and meteorology course covers meteorology basic weather studies. This course provides knowledge about atmospheric environment, world weather types.

Learning outcomes:
Students will get knowledge on tropical weather and different weather data sources and climatology of Bangladesh.

Course contents:
1. Introduction to meteorology: The causes of weather, Raw materials of weather studies.

2. Air-Mass: Properties and types, Clouds as Air-Mass characteristics, Different geographic Air- Masses (Tropic to polar).
3. Atmospheric Circulation: Pressure and winds, Forces of balance, The Mechanisms of lows and highs, Thermal system, early circulation model.
4. Fronts and Frontal disturbances: Air Mass boundaries, Active and Inactive Fronts, Warm and Cold Fronts, Depression weather.
5. World weather types: Equatorial, Tropical, Desert, Mediterranean, Temperate and Polar weather. Tropical Monson weather and tropical cyclone.
6. The processing of weather information: Weather station devices, weather station at sea, weather information from the satellite.
7. Weather Forecasting: Conventional forecasting methods, Numerical models, Cyclone forecasting and warning system.
8. Tropical meteorology: data sources (Oceanographic data, Satellite data, weather data, radar data); Pressure and winds; Temperature and water vapor; Clouds and rainfall etc.
9. Climatology of Bangladesh and adjacent Bay of Bengal: Physical features, seasonality of pressure, temperature, winds, humidity, rainfall, cyclonic storms and depressions, etc.
10. Tropical meteorology: data sources (Oceanographic data, Satellite data, weather data, radar data); Pressure and winds; Temperature and water vapor; Clouds and rainfall etc.

OCN 4110 Ocean Forecasting and Meteorology Practical 1 CH

Scope and Objectives:

The course is designed to give the the students an overview of conducting ocean forecasting and weather analysis. It covers observation and measurement of different ocean and weather variables, modeling climate data, preparation of weather summaries and forecasting specially in reference to Bangladesh.

Learning Outcomes:

Students wil be able to measure different ocean and weather variables, prepare weather summaries and forecasts.

Course Contents:

1. Geo-referencing of weather spot in the global scale.
2. Measurement of wind speed, direction and record keeping.
3. Measurement of humidity, precipitation and evaporation rate.
4. Interpretation of weather data, different data sources.
5. Modeling climate data and forecasting – a simple model practice.
6. Analysis of tropical storms and computation of wind speed in the storm field
7. Preparation of weather summaries and forecasts.

Recommended Books

1. Moses, L L & Tomikel (1981) Basic Meteorology: An Introduction to the Science. Allegheny Press, ISBN 091004203.
2. Miller, A & M Parry (1975) Everyday Meteorology. Hutchinson of London.
3. Kendrew, W G (1943) Weather: An Introductory Meteorology. Oxford University Press.

OCN 4111	Research Methodology	3 CH

Scope and Objectives:
The course is designed to provide knowledge on scientific research. It will cover selecting and defining a research problem, design of research plan, sampling strategies and methodology, data collection, accuracy of results, qualities of a good research, presentation of research findings and research extension processes as well as problems of research in Bangladesh and BoB.

Learning Outcomes:
Students wil develop the capabilities required to conduct scientific research and presentation of research outputs.

Course Contents:

1. Introduction to research methodology, meaning, objectives, types of research, methodology vs. methods, research process, qualities of a good research, problems of research in Bangladesh
2. Selecting and defining a research problem, Techniques of defining a problem.
3. Design of research plan, meaning of research design, need for research design, various research design.
4. Sampling strategies and methodology design of sampling programs, water parameters, sediments, bacteria, plankton, benthos and nekton.
5. Data collection (Primary Method): Collection of data through questionnaires. Collection of data through Schedule, Difference between Questionnaires and Schedules, constructing questionnaire and schedule.
6. Data collection (Secondary Method): Various Methods of Secondary data collection.
7. Case study Method
8. Accuracy of results
   - 8.1 Types of errors and their control.
   - 8.2 Replication and standard samples.
   - 8.3 Degrees of accuracy, calculations and level of significance
9. Presentation of research findings
   - 9.1 Data processing, data analysis, graphical representation, Statistical & ecological analyses and tabulation.
   - 9.2 Manuscript preparation (thesis/dissertation).
   - 9.3 Writing techniques of research proposal for funding
   - 9.4 Monitoring and evaluation of research projects
   - 9.5 Research report preparation
10. Research extension processes (seminar, symposium, workshop, training program, popular and scientific paper publication).

OCN 4112	Field Trip	1 CH

Forth Year
Semester II

OCN 4201	**Port and Shipping Management**	**3 CH**

Scope and objectives:
The course covers the port and development, personnel, roles and functions. There is a scope to know about port management and economics.

Learning outcomes:
Students will know about introductory to maritime logistics. The students have scopes to know about dredging, dumping and blast water management.

Course contents:

1. Introduction to Port Management
   Introduction to ports and port development; ports personnel, roles and functions; key stakeholders (identifying stakeholders, understanding stakeholders' concerns, communicating with stakeholders); port and terminal operations; types of ports; operating models; ports vs. terminals; vessels, cargoes and terminal types; port and cargo movement; intermodal/hinterland transport; competition and other challenges facing the industry
2. Port Economics and Management
   Port economics; demand/supply and different categories of ports; port performance and productivity; finance and pricing of port and terminal services, forecasting demand and capacity; port and terminal operations; public-private partnerships (i.e. private sector participation in terminal ownership and management)
3. Port Design and Engineering
   Port planning; port demand; feasibility studies; infrastructure development and re-engineering; minimizing environmental impact; port design; approaches; quays; estate; port engineering; maintenance strategies; planning maintenance; condition based maintenance; asset registers; incorporating statutory requirements
4. Port Design and Engineering
   Port planning; port demand; feasibility studies; infrastructure development and re-engineering; minimizing environmental impact; port design; approaches; quays; estate; port engineering; maintenance strategies; planning maintenance; condition based maintenance; asset registers; incorporating statutory requirements
5. Introduction to Maritime Logistics
   Maritime law; maritime transport, operations and logistics; container logistics; supply chain management
6. Key Issues for Global Supply Chain and Logistics Management
   Developments impacting on the supply chain; logistics processes; logistics network planning; inventory and the integrated supply chain; problems with traditional approaches to inventory planning; new inventory requirements; the lead-time gap; logistics and the environment; best practice; reverse logistics
7. Dredging, Dumping and Blast water management
   Dredging of the port area, Causes of Dredging, long term and short-term effect for dredging; Dumping impact and problems of the port management;

Source of blast water,
Contamination of flora and fauna in the native waters.

Recommended Books

1. Photis Panayides. Maritime Logistics: A Complete Guide to Effective Shipping and Port Management, Dong-Wook song.

OCN 4203 Marine Biodiversity and Conservation 3 CH

Scope and objectives:
The course is designed to know about basic concept of biodiversity, different ecosystems in marine biodiversity. There is opportunity to know genetic and species variation in marine biodiversity.

Learning outcomes:
Students will know different methods of measuring biodiversity, the value of biodiversity and types of threats to biodiversity. The conservation of marine biodiversity learning is another outcome of this course.

Course contents:

Biodiversity

1. Introduction
   - 1.1 Definition and concepts
   - 1.2 Genetic, species and ecosystem biodiversity
2. Measuring Biodiversity
   - 2.1 Number and differences
   - 2.2 Surrogacy
   - 2.3 Richness
   - 2.4 Evenness
3. The Value of Biodiversity
   - 3.1 Ecological value
   - 3.2 Ethical value
4. Threats to Biodiversity
   - 4.1 Extinctions
   - 4.2 Extinctions of the Past
   - 4.3 Human-caused extinctions: Extinction rates, Vulnerability of extinctions, Causes of extinctions: exploitation, habitat destruction, degradation and pollution, biological invasions

Conservation

1. Definition and Concepts
2. Importance of Conservation
3. The Rise of Modern Conservation
4. Approaches of Conservation
5. Biodiversity conservation inside Protected Areas
   - 5.1 Establishing Protected Areas
   - 5.2 Designing Protected Areas
   - 5.3 Measuring Protected Areas: Protected Areas and people
6. Biodiversity conservation outside Protected Areas
7. International Agreements on Biodiversity Conservation

Recommended books

1. Biodiversity: An introduction, by K.J. Gaston and J.I. Spicer. Blackwell Science, UK, 1998.
2. Species diversity in space and time, by M.L. Rosenzweig, Cambridge University Press, 1995.
3. Species diversity in ecological communities: Historical and geographical perspectives, by R.E. Ricklefs and D. Schulter. Chicago University Press, 1993.
4. Paradise lost? The ecological economics of biodiversity, by E.B. Barbier, LJ.C. Burgess and C. Folke. Earthscan, London, 1994.
5. Biodiversity, by E.O. Wilson and F.M. Peter. National Academic Press, Washington, 1998.

OCN 4205 Ocean Modelling 3 CH

Scope and objectives:
There is a scope of learning about fundamental ocean modeling in this course. This course contains types of ocean modeling.

Learning outcomes:
The students will learn basic components of general ocean modeling. They will gather deep knowledge about different modeling techniques. They will able to use statistical methods in ocean modeling.

Course Contents:

1. General concept of modelling
   - 1.1 Biological model
   - 1.2 Ecological model
   - 1.3 Mathematical models
   - 1.4 Open ocean models
   - 1.5 Upper Ocean Seasonal models
2. Biological model and its abiotic and biotic components
3. Modelling Techniques
   - 3.1 Ordinary differential equations
   - 3.2 Numerical modelling
   - 3.3 Gyre models
   - 3.4 General circulation models
   - 3.5 Inverse methods and Assimilation Techniques
4. Modeling Case Studies
   - 4.1 Mathematical basis of population models
   - 4.2 Tropic level marine ecosystem models
   - 4.3 Ocean models
   - 4.4 Sedimentary systems.
   - 4.5 Air-sea gas exchange and gas transfer models.
   - 4.6 Box model for nutrients flux analysis
5. Statistical analysis and numerical modelling for oceanography data
   - 5.1 Probability distribution
   - 5.2 Least souare and regressoin model, goodness of fit, linear and non linear least squaries techniques
   - 5.3 Principle componentsand factor analysis 1 & 2

5.4 Time Series analysis.

OCN 4206	Ocean Modelling Practical	1 CH

Scope and objectives:
The ocean modeling practical consists of open ocean models and different components of factor analysis.

Learning outcomes:
The students will get confidence on understanding biological and ecological ocean models.

Course contents:

1. Data acquisition and analyses of biological, ecological and open ocean models.
2. Analysis of Least square and goodness of fit data.
3. Principle component and factor analysis.
4. Time series analysis.

Recommended Books

1. Modeling Methods for Marine Science, Glover, Jenkins and Deney.
2. Applied Factor Analysis in the Natural Sciences, Reymont and Joreskog.
3. Regional Ocean Modeling System (ROMS) NPZD, Gruber et al, 2006.
4. Water and water pollution handbook, Vol 1, L.L. Claccio.

OCN 4207	Integrated Coastal Zone Management	3 CH

Scope and objectives:
This course covers basic concept of coastal zone. It is aimed to learn the types of coastal zones, coastal landforms in this course.

Learning outcomes:
The students will acquire knowledge about the coastal planning and the opportunities in coastal areas. They will learn about the coastal zone management strategies, sustainable use of resources in Bangladesh very intensively.

Course contents:

1. Definition of Coastal Zone, Types of coastal landforms, Coastal ecosystems, Coastal forces and processes.
2. Land use pattern and human alterations of the coastal zone, Coastal management issues: coastal storm mitigation, Shoreline erosion and sea level change, Protection of coastal waters, protection of coastal wetlands, Energy development and the coast, Biodiversity and Habitat conservation, Marine and fishery management, Coastal land use pressure, social equity in coastal planning.
3. Development impacts: Agriculture, aquaculture, forest industries, heavy industries, mining, Petroleum, Ports, tourism, settlements, waste disposal, shore protection works.
4. Stakeholders of coastal management, role of GO, coastal policy, CZM act, national marine sanctuary program.
5. Coastal management strategies, sustainable use of resources, biological diversity, pollution control, protection against natural hazards.
6. Coastal zone management strategies for Bangladesh

7. Socio-economic concerns, alternative livelihoods, social impact assessment.
8. Management: aquaculture management, beach management, Coral reef management, Dredging management, Dune, mangrove forest, water quality management.
9. Monitoring Coastal Environments using Remote Sensing, GIS applications in Coastal management.

Recommended books

1. Timothy Beatley, David J. Brower, Anna K. Schwab. 2005. Introduction to Coastal Zone Management. 2nd Edition. Island Press. Washington D. C. 20009
2. John R Clark. 2005. Coastal zone management Hand book. CRC press
3. Darius Bartlett and Jennifer Smith, Eds. 2004. GIS for Coastal Zone Management: CRC press
4. Haq, B. U. et al. 1997. Coastal Zone Management: Imperative for Maritime Developing Nations. Kluwer Academic Publishers. 394 pp.

OCN 4209 Seafloor Exploration and Seismology 3 CH

Scope and objectives:
To know the definition and types of mineral resources of the sea. To know about the mineral deposits and distribution in ocean. To learn about the origin, migration and accumulation of petroleum.

Learning outcomes:
The students will study different types of maps to locate resource distribution and offshore exploration by this course.

Course Contents:

1. Introduction and classification of mineral resources of the sea:
   1.1 Terrigenous, biogenous and chernogenous mineral deposits,
   1.2 Placer mineral deposits, mode of occurrence
   1.3 Minerals of the continental shelf
2. Minerals of the deep-sea floor:
   2.1 Physical and chemical aspects of polymetallic nodules
   2.2 Formation, distribution and concentration
   2.3 Manganese crust and their occurrence and composition
   2.4 Hydrothermal sulfides, their location and occurrence
   2.5 Present production of marine minerals and prospects
   2.6 Petroleum and gas from the continental margins of Bangladesh
3. The occurrence of petroleum and another hydrocarbon:
   3.1 Mode of occurrence- surface occurrence, subsurface occurrence.
   3.2 The origin of petroleum: Inorganic origin – organic origin
   3.3 The nature of organic source material
   3.4 Marine organic matter – transformation of organic matter into petroleum
4. Migration and accumulation of petroleum:
   4.1 Geologic frame work of migration and accumulation – secondary migration,
   4.2 Reservoir rocks, classification – fragmental reservoir rocks,
   4.3 Chemical reservoir rocks – marine and non-marine reservoir rocks.
   4.4 Subsurface geology and subsurface methods.
5. Structural maps, Isopach maps, Facies maps, Paleo geographic maps, Geophysical maps, geochemical maps.

6. Oil field water, physical properties of oil, reservoir pressure and temperature pressure gradient, elements of drilling and well completion drilling
7. Hydrocarbon detectability, seismic resolution
   7.1 The delineation of reservoirs
   7.2 The main indications of reservoirs – mud filtrate invasion.
8. Offshore Exploration:
   8.1 Positioning in the sea
   8.2 Echo sounding and scanned sonar methods
   8.3 Offshore mining

Recommended Books

1. Mineral Resources of the Sea, U. Nations.
2. Elements of Petroleum Geology, R. C. Seley.

OCN 4211	**Research Project**	**6 CH**
OCN 4202	**Viva Voce**	**2 CH**