COURSE CURRICULUM

General Information

1. **Name of the Programme**. **BSc (Hons) in Oceanography**

2. **Duration of the Programme**. The Program is a 4 years full time regular undergraduate program. The program is divided into eight semesters of 6 months each (2 semesters in each year). The duration of each semester is 26 weeks. In each semester, 15 weeks are dedicated for Classroom Learning and Field Trip, while remaining weeks are utilized for makeup classes, midterm examination, preparatory leave, final examination, other curricular and co-curricular activities. Distribution is as follows:

a.	Classes/ Field Trip	15 weeks
b.	Mid Term Examinations & Make up Classes	02 weeks
c.	Preparatory Leave	02 weeks
d.	Term Final Examination	03 weeks
e.	Recess	04 weeks

3. **Credits of the Programme**. 160 Credits.

Admission Criteria

4. Applicants must fulfil the admission requirements as prescribed by Bangabandhu Sheikh Mujibur Rahman Maritime University, Bangladesh (BSMRMU). To be eligible for admission in the program, a candidate must pass SSC/ Dakhil and HSC/Alim examinations or its equivalent in Science discipline. Minimum qualifications to take part in the admission test are as follows:

a. Applicants who have passed HSC or equivalent examination in the current year or one year before the notification for admission are eligible to apply.

b. Applicants must have passed SSC/equivalent examination and HSC/ equivalent examination from Board of Intermediate and Secondary Education/ Madrasa Education Board/ Technical Education Board in Science group with minimum GPA 4.00 in a 5-point scale.

c. In HSC/Alim/ equivalent examination the applicant must have obtained minimum “A” grade in any two (02) Courses out of five (05) courses including

Mathematics, Physics, Chemistry, Biology and English with minimum "B+" (B plus) grade in rest Courses.

d. Applicants with GCE must have passed at least five subjects in O level (including physics, chemistry, mathematics) and at least two subjects in A level (including physics/mathematics). However applicant having more than two 'C' grades in O level and/or more than one 'C' grades in A level shall not be eligible for admission.

e. Foreign applicants shall apply through their respective embassy. Educational qualifications are same as applicable for Bangladesh students.

Admission Test

5. The admission notice shall be circulated usually in the month of August/September of each year through media advertisement, BSMRMU website and notice board. All eligible applicants shall be required to appear the admission test as per BSMRMU Admission Policy. Admission test shall normally be comprised of written test. Syllabus of admission test shall be that of current HSC Syllabus. The subject of written admission test are as follows:

a. Physics
b. Chemistry
c. Mathematics
d. Biology
e. English

6. However BSMRMU reserves the right to call qualified candidates for interview before final selection.

Final Selection

7. The merit list shall be prepared according to combined marks obtained by candidates in the written admission test. The marks for public examinations shall be calculated in a simple linear distribution method from candidates GPA. The weightage of written admission test and public examination shall be as follows:

Ser No	Description	Marks	Remarks
1.	Admission Test	120	SSC+HSC-80 Marks (SSC/equivalent -40%, HSC/equivalent-60%)
2.	HSC/equivalent	48	
3.	SSC/equivalent	32	
Total		200	

Registration/Admission in the Program

7. After final selection, selected candidates shall be registered with the programme in accordance with the procedures as laid down by BSMRMU. The candidates to go through a medical checkup at BSMRMU designated Medical Centre to ascertain their medical fitness. The selected candidates shall have to collect Admission Form from Admission Section and

complete admission and registration formalities within the given time frame by paying required fees. The following rules shall apply in this regard:

a. Candidate failing to complete admission formalities within the prescribed time from, his/ her selection will be considered as cancelled.

b. Student who fails to attend the class within two weeks of the commencement of 1st semester class, his/her admission will be considered as cancelled.

Grading System

8. Letter grades and corresponding grade points will be awarded in accordance with the provisions (unified UGC grading system) shown below:

Grade	**Grade points**	**Numerical Markings**
A+	4.0	80% and above
A	3.75	75% to below 80%
A-	3.50	70% to below 75%
B+	3.25	65% to below 70%
B	3.00	60% to below 65%
B-	2.75	55% to below 60%
C+	2.50	50% to below 55%
C	2.25	45% to below 50%
D	2.00	40% to below 45%
F	0.00	below 40%
I	Incomplete	-
W	Withdrawn	-
X	Thesis continuation	-
E	Expelled	Due to exam offence

Conduct of Courses

9. In a semester, teacher/teachers shall be assigned to plan and teach a particular course. The following guidelines shall be followed for conduct of courses:

a. At the beginning of the semester, the course teacher will prepare a course outline incorporating the course syllabus, performance evaluation and grading system (as laid down in the policy), list of suggested text books/references, and a tentative schedule of classes, examinations and events.

b. **Assignment of Credits.** The assignment of credits to theoretical course is different from that of laboratory course, which is stated as follows:

(1) For theoretical courses one lecture of 60 minutes per week per term is equivalent to one credit.

(2) For laboratory courses three class hours per week per term is equivalent to one credit.

(3) Credits are also assigned to thesis work taken by the students. The amount of time assigned to such work may vary depending on the thesis.

c. A thesis work shall be assigned, either individually or in groups on any issue pertaining to the course.

d. A number of individual and group assignments, presentations, etc shall be assigned to students as per the course requirements.

Performance Evaluations

10. For Theory Courses. Fifty percent (50%) of marks of theoretical course shall be allotted for continuous assessment, i.e. quizzes, class tests, home assignments, class evaluation and class participation etc. Term Final Examination is conducted centrally by BSMRMU. Term Final Examination will be normally of 3-hours duration. Distribution of marks for a given course is as follows:

a. Class Attendance -05%

b. Class Participation/Observation - 05%

c. Term Paper/Assignment - 10%

d. Quizzes/Class Test -10%

e. Mid Term Examination (01 Exam) - 20%

f. Term Final Examination -50%

11. The number of quizzes/ class tests of a theory course shall be *n+1,* where *n* is the number of credits of the course. Evaluation of performance in quizzes/ class tests will be on the basis of the best *n* quizzes. The scheme of continuous assessment that a particular teacher wishes to follow for a course will be announced as course outline on the first day of the term. The performance of a student will be evaluated in terms of two indices, viz. Semester Grade Point Average (SGPA), and Cumulative Grade Point Average (CGPA).

12. For Practical Courses. The distribution of marks for three types of Laboratory is given below:

a. Project /Lab Test/ Computer Test - 40%

b. Quiz - 20%

c. Viva/ Presentation - 10%

d. Attendance - 10%

e. Assignment / Report - 10%

f. Class Performance / Observation - 10%

13. For Field Trip

a. General Observation/ Participation - 20%

b. Report Submission - 40%

c. Presentation - 40%

The requirements for promotion to the Next term

14. The requirements for promotion to the next term are as follows:

a. A student has to take the required courses for a particular term/level as per the syllabus of the program.

b. A student shall be promoted to the second term (Term-II) of each level, irrespective of his/her results in the first term of the level provided he/she does not have 'F' grades in more than two subjects including backlog subjects (if any).

Credit Earned

15. The Courses in which a student has obtained 'D' or a higher Grade shall be counted as credits earned by him/her. Any course in which a student has obtained 'F' grade shall not be counted towards his/her earned credits 'F' grade must be cleared within designated period.

Degree Requirements

16. Degree requirements are as follows:

a. Completion of courses for the minimum required credits of 160 in maximum period of Six academic years.

b. Appearing at the final examination in all the required courses as per syllabus of the programme.

c. Successful completion of defence of thesis paper.

d. Scoring a CGPA 2.25 or above.

Retaking a Course

16**.** It is expected that students will obtain degree by clearing the entire offered courses of specified credit hours as per the syllabus within six academic year's period. In case of failure to do so by any student the following guiding policies shall be adopted:

a. A student obtaining F grade in a course may be allowed to repeat the course with the prior approval of Head of the Department on the recommendation of the course coordinator. Such approval shall be reported to the BUGSR and academic council.

b. Two courses of any semester may be repeated for improvement with the prior approval of the Head of the Department on the recommendation of the course coordinator. Such approval shall be reported to the BUGSR and Academic Council.

Course Designation System

17. Each course is designated by a maximum of four letter code identifying the department offering the course followed by a four-digit number having the following interpretation:

a. The first digit corresponds to the year/level in which the course is normally taken by the students.

b. The second digit corresponds to the semester/ term in which the course is normally taken by the students.

c. The last two digits denote various courses, where an odd number is used for theoretical courses and an even number for Laboratory/Practical courses.

Semester Wise Distribution of the Courses

18. Semester wise Distribution of the courses are given below:

Semester 1:			
SL	**Sub Code**	**Subject**	**Credit**
1	OCN 1101	Marine Ecology	3
2	OCN 1102	Marine Ecology Lab	1.5
3	OCN 1103	Marine Resources	3
4	OCN 1105	Communicative English	3
5	OCN 1107	Physics	3
6	OCN 1108	Physics (Lab)	1.5
7	OCN 1109	Mathematics	3
8	OCN 1111	Field Trip	1.5
		Total	**19.5**
Semester 2:			
9	OCN 1201	Chemistry	3
10	OCN 1202	Chemistry Lab	1.5
11	OCN 1203	Bangladesh and Bay of Bengal Studies	3
12	OCN 1205	Numerical Techniques for Oceanographers	3
13	OCN 1207	Computer Programming for Oceanographers	3
14	OCN 1208	Computer Programming for Oceanographers (Lab)	1.5
15	OCN 1209	Physical Ocenography	3.0
16	OCN 1210	Physical Ocenography Lab	1.5
		Total	**19.5**
Semester 3:			
17	OCN 2101	Chemical Oceanography	3
18	OCN 2102	Chemical Oceanography (Lab)	1.5
19	OCN 2103	Marine Invertebrates	3
20	OCN 2104	Marine Invertebrates (Lab)	1.5
21	OCN 2105	Marine Vertebrates	3.0
22	OCN 2106	Marine Vertebrates (Lab)	1.5
23	OCN 2107	Statistical Techniques for Oceanographers	3
24	OCN 2109	Field Trip	1.5
		Total	**18.0**
Semester 4:			
25	OCN 2201	Geological Oceanography	3
26	OCN 2202	Geological Oceanography (Lab)	1.5
27	OCN 2203	Fisheries Oceanography	3
28	OCN 2204	Fisheries Oceanography (Lab)	1.5
29	OCN 2205	Biological Oceanography	3
30	OCN 2206	Biological Oceanography Lab	1.5
31	OCN 2207	Law of the Sea	3
32	OCN 2209	Marine Planktology	3
33	OCN 2210	Marine Planktology (Lab)	1.5
		Total	**21.0**

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Semester 5:			
34	OCN 3101	Sedimentology	3
35	OCN 3102	Sedimentology (Lab)	1.5
36	OCN 3103	Oceanographic Instrument	3
37	OCN 3105	Meteorology and Ocean Forecasting	3
38	OCN 3107	Seismology and Hydrocarbon Exploration	3
39	OCN 3109	Environmental Impact Assessment	3
40	OCN 3111	Paleontology	3
41	OCN 3113	Field Trip	2
		Total	**21.5**
Semester 6:			
42	OCN3201	Geophysical Fluid Dynamics	3
43	OCN 3203	Seamanship and Navigation	3
44	OCN 3205	Hydrography	3
46	OCN 3206	Hydrography (Lab)	1.5
47	OCN 3207	Marine Biogeochemistry	3
48	OCN 3209	Marine Microbiology	3
49	OCN 3210	Marine Microbiology (Lab)	1.5
50	OCN 3211	Acoustical Oceanography	3
		Total	**21.0**
Semester 7:			
51	OCN 4101	Research Methodology	3
52	OCN 4103	Satellite Oceanography	3
53	OCN 4105	Coastal and Marine Pollution	3
54	OCN 4106	Coastal and Marine Pollution Lab	1.5
55	OCN 4107	Marine Ecosystem Modeling	3
56	OCN 4108	Marine Ecosystem Modeling (Lab)	1.5
57	OCN 4109	Data Collection & Analysis in Oceanography	3
58	OCN 4110	Data Collection & Analysis in Oceanography (Lab)	1.5
59	OCN 4111	Field Trip	2
		Total	**21.5**
Semester 8:			
60	OCN 4201	Integrated Coastal Zone Management	3
61	OCN 4203	Coastal Morphology and Process	3
62	OCN 4205	Marine Biodiversity and Conservation	3
63	OCN 4207	Global Climate Change	3
64	OCN 4209	Thesis	6
		Total	**18.0**
Grand Total - 160 Credits			

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MARINE ECOLOGY

Course Code : **OCN 1101**
Credits : 3.0

Objective:

To introduce students to the principal coastal and oceanic ecosystems as well as to explore how environmental variables affect biological communities and ecological interactions.

Syllabus Contents:

1. Definition, scope and type of ecology
2. Marine environment: General concepts, the open water, coastal water, the floor of the sea
3. Coastal habits: beaches, dunes & shingle, Islands, coral reef, salt marshes, sea grass and seaweeds
4. Major ecological divisions of marine habit
5. Comparative study of the flora and fauna of fresh water, brackish water and marine ecosystems
6. Floral and faunal characteristics of sandy, muddy and rocky beaches
7. Factors controlling the adaptation and distribution of marine organisms
8. Food chain, food webs and ecological niche in marine environment
9. Ecology of the Bay of Bengal and its major estuaries (Karnaphuli river estuary, Passur river estuary, Mathamuhuri river estuary, Naf river estuary and Meghna river estuary)
10. Geographical position and comparative study of the three major oceans (Indian, Pacific and Atlantic oceans)
11. Concepts of Biodiversity: Definition, types, patterns, factors causing lose of biodiversity

Recommended Text(s):

1. Marine Ecology, by RV. Tait
2. Fundamental of Ecology, by EP Odum
3. An Introduction to Marine Science, by PS Meadows and JI Campbell
4. The Ocean, by HU. Sverdrup and *etal*.k

MARINE ECOLOGY (LAB)

Course Code : **OCN 1102**
Credits : 1.5

Objective:

To learn how to analyze ecological data and how to write research reports in scientific format which are accomplished through laboratory and field trip activities.

Syllabus 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 selected aquatic organisms
5. Mangrove Study (Prepare a checklist and identification of Mangrove flora and fauna)
6. Coral reef ecology-an orientation with corals and coral reef species and chemical process coral bleaching
7. Identification of commercially important sea-weeds and sea-grasses

MARINE RESOURCES

Course Code : **OCN 1103**
Credits : 3.0

Objective:

To explore ways of improving the sustainability of exploited marine resources and the protection of the near pristine coral reef ecosystem.

Syllabus Contents:

1. **Animal resources:**

   1.1 **Marine Invertebrates**: Structural Support, Locomotion, Feeding, Defence and Camouflage; Parasitism,Commensalism, Symbiosis; Sensory perception,; Reproduction; Life cycle, Larvae and Settlement; distribution and Evolution; Importance and uses. (Crustaceans, Molluscs, Sponges, Starfish, Coral etc.)

   1.2 **Marine Vertebrates**: Evolutionary history of Marine Vertebrates; Classification, Identification, Habitat, Life cycle, Distribution, Locomotion, Feeding, Breeding and Reproduction, Importance and uses etc(Marine fishes, Marine Reptiles, Sea birds, Cetaceans, Sirenians, Pinnipeds and Marine Otters).

2. **Plant resources:** (Marine algae, Sea grass, Salt marsh and Mangroves) Definition, Taxonomy, Adaptation, Physiology, Ecological roles, Importance and uses

3. **Salt production**: General concept, Types of salt, Solar salt production processes in Bangladesh, Salt quality, Food and other uses in Bangladesh.

4. **Tourism:** Present status and future prospects of coastal and Marine tourism, Coastal and Marine tourism scope and facilities in Bangladesh (Cox's Bazar, Chittagong, Kuakata and Khulna region).

5. **Sea port:** Geographical position of Chittagong Sea Port and Mongla Sea Port, Pyra Sea Port history, commercial importance, Facilities and problems.

6. **Ship recycling**: Ship breaking history in Bangladesh, Environmental issues and Social effect.

7. **Heavy minerals:** Introduction, Types, Transportation Deposition, Distribution, Extraction of heavy minerals, Beach heavy minerals in Bangladesh.

8. **Marine Gas and Oils:** General concept, types of gas and oils, formation, distribution, inshore and offshore exploration.

9. **Mari culture (based on shrimp farming):** Present status in national economy, Mari culture innovated technology transfer by Inst. of Marine Sciences and Fisheries, University of Chittagong. Evolutionary history of Mari culture in Bangladesh.

Recommended Text(s):

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.

COMMUNICATIVE ENGLISH

Course Code : **OCN 1105**
Credits : 3.0

Objective:

To help students improve reading, writing, speaking and listening skills so that they can acquire communicative skills

Syllabus Contents:

1. **Functional Grammar**

Right forms of verbs, Use of tenses, Parts of Speech, Articles, Use of active and passive voice, Appropriate preposition, Use of modal verbs, Subject verb agreement, Narration, Transformation, Conditionals, Tag questions, Error corrections

2. **Developing Reading Skills**

Reading strategies (skimming, scanning, predicting, guessing etc), Methods of developing reading skills, Practicing reading comprehension using different reading selections from science, history, linguistics or other areas, Reading to summarize the main points of text, Reading to improve linguistic skills and expand vocabulary

3. **Developing Writing Skills**

Writing strategies: free-writing, brainstorming, mind mapping/clustering, narrowing the focus etc, Paragraph writing, Organizing a paragraph: topic sentence, detailed sentences, logical orders and conclusions, Writing different types of essays: narrative/descriptive, argumentative, cause effect, exploratory, Letter and email writing, Translation from Bangla to English and vice versa

4. **Developing Speaking Skills**

Practicing speaking English on everyday life situation, Guided conversations (greetings, requesting, apologizing), Two- minute impromptu talks, Preparing and presenting talks on a given theme, Oral presentation, Responding to audio/video clips, Learning IPA symbols

5. **Developing Listening Skills**

Listening for main ideas/key information, Listening for specific details, Listening and note-taking, Listening to news, broadcasts and songs

Recommended Text(s):

1. *Headway* (Upper Intermediate) by Liz and John Soars
2. *English Grammar & Composition*, by Wren and Martin
3. *Friends' Language Grammar, Reading Comprehension, Writing Composition* by Prof. Ataul Haque, Prof. Jahurul Islam, Dr. Binoy Barman
4. *Mastering Language Skills* by S M Amanullah

PHYSICS

Course Code : **OCN 1107**
Credits : 3.0

Objective:

To help students understand why things in the natural world happen, the way they do and being able to make accurate quantitative predictions in realistic situations.

Syllabus Contents:

1. General considerations of physics and their relevance to oceanography

2. **Physical quantities**: Scalars, vectors, scalar product, vector product and gradient

3. **Newton's laws of motion**: concepts of force and mass: applications of Newton's law, linear and angular momentum

4. **Work and Energy**: work done by a constant force; power; kinetic and potential energies; conservation of momentum and energy

5. **Oscillation**: The simple harmonic oscillation; its amplitude, frequency, time period and energy

6. **Gravitation**: Newton's law of universal gravitation; universal gravitational constant; acceleration due to gravity(g), gravitational effect of spherical distribution of matter; motion of planets and satellites; energy in a gravitational field

7. **Surface tension**: Rise of liquid in a capillary tube, angle of constant; temperature and surface tension

8. **Fluid**: Fluid pressure; hydrostatic equation; viscous fluid; poiseulles equation

9. **Heat and Thermodynamics**: The Celsius and Fahrenheit temperature and scales; absolute temperature; specific heat; conduction, convection, and radiation of heat, mechanical equivalent of heat; first law of thermodynamics; thermodynamics processes

10. **Light**: Reflection, refraction, transmission and absorption; electromagnetic radiation, solar spectrum solar constant

11. Basic concepts on (a) electricity (b) electronics and (c) radioactivity

Recommended Text(s):

1. Physics for students of Science and Engineering, Part 1 and II, NY. Wiley
2. Text book of heat, T. Hossain
3. A text book of magnetism, electricity and modern physics, by M. Kalimuddin.

PHYSICS LAB

Course Code : **OCN 1108**
Credits : 1.5

Objective:

To understand a broad range of experimental and data-analysis techniques and demonstrate learners to use these techniques in both designing and conducting scientific experiments and observations.

Syllabus Contents:

1. Surface tension of water
2. Specific heat
3. Measurement of temperature, resistance and electricity
4. Newton's ring experiment
5. Plotting and interpretation of graphs
6. Archimedes' Principle (Buoyancy)
7. The Nature of Sound and determination of sound speed
8. Physical optics (wave length and light propagation)
9. Thermal physics

10. Showing videos on the processes of Earth System (Coriolis force, ocean circulation etc.)

MATHEMATICS

Course Code : **OCN 1109**
Credits : 3.0

Objective:

To develop abstract, logical and critical thinking and the ability to reflect critically upon their work and the work of others.

Syllabus Contents:

1. **Algebra**
   1.1 Set theory: Sets, Null sets, subsets, disjoint sets, Universal sets, power set, Venn diagrams, basic set operations such as union, intersection, difference, complements
   1.2 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
   1.3 Matrix: Definition of different matrices, rule of multiplication of matrices, ad joint matrix, inverse matrix, hermit Ian matrix, orthogonal matrix, solution of linear equations

2. **Differential Calculus**
   2.1 Functions, limit, exponential function, derivative & higher order derivatives, rule of differentiation of standard functions, partial and total differentiation, change of variables

3. **Integral Calculus**
   3.1 Integrals of standard functions, exponential functions, definite integrals, double integrals (concept of surface and area)

4. **Differential Equations**
   4.1 Ordinary differential equation of 1st & 2nd order

5. **Logarithms**
   5.1 Definitions, derivatives, Basis of natural logarithms

6. **Vector Analysis**
   6.1 Vector & Scalars, rectangular co-ordinate system, components of vectors, laws of vector algebra, scalar field, vector field, gradient, divergent & curl-of-scalar and vector functions

Recommended Text(s):

1. Fundamentals of modern mathematics, by JM Calloway, 1964
2. Algebraic and arithmetic structures, by Bell et al, 1976
3. A text book on differential calculus, by Mohammad et al, 1995

4. Differential equations, by BD Sharma
5. Calculus with analytic geometry, by H Flanders and JJ Price, 1978
6. Liner algebra, by S Lipschutz, 1987

CHEMISTRY

Course Code : **OCN 1201**
Credits : 3.0

Objective:

To provide a broad foundation in chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective.

Syllabus Contents:

1. Modern concept of the structure of atom
2. Periodic classification of elements: General treatment and application
3. Concept of valence: General treatment of the different bond types, bond angles, shapes of molecules
4. Modern views on acids and bases
5. Classification of chemical reactions
6. Oxidation and reduction reactions
7. Principles of volumetric analysis, pH and buffer action, uses of different types of indicators
8. General study (nomenclature, methods of preparation, physical properties, reactions and important uses) of aliphatic, alicyclic and aromatic compounds polycyclic compounds, natural alkaloids
9. Diffusion, osmotic pressure, colloids, emulsions, depression of freezing point, (flouressure, phosphorescence).

Recommended Text(s):

1. Introduction to modern inorganic chemistry, S.Z. Haider
2. Organic chemistry, A. Khalique
3. Principles of physical chemistry, MM. Hoque and MA. Nawab.

CHEMISTRY LAB

Course Code : **OCN 1202**
Credits : 1.5

Objective:

To develop the ability to perform accurate quantitative measurements with an understanding of the theory and use of contemporary chemical instrumentation through proper interpretation of experimental results.

Syllabus Contents:

1. Preparation of solutions and Volumetric analysis
   a. Acid base titrations
   b. Oxidation reduction titrations
2. Precipitation titrations
3. Preparation of standard
   a. N/10 $K_2Cr_2O_7$ solution and
   b. Standardization of $Na_2S_2O_3$
4. Sea water properties analysis

BANGLADESH AND BAY OF BENGAL STUDIES

Course Code : **OCN 1203**
Credits : 3.0

Objective:

To assess the problems of environmental degradation in the coastal ecosystems in the Bay of Bengal by reviewing the existing information, analyzing available data and collating it all as a fundamental information base.

Syllabus Contents:

1. **Introduction:** Location, boundary, historical perspectives, human occupancy

2. **Physical Oceanography of the Bay of Bengal:** Continental shelf: Bottom topography, bathymetric changes, sediment dispersal Ocean dynamics; Tidal characteristics, vertical and horizontal distribution of ocean temperature, salinity and density; aerial and seasonal variation of ocean currents, sediment transport, estuaries and estuaries dynamics, Acoustical and optical characteristics of seawater – SOFAR channel, Shadow zone – color of the sea. Thermal Inversion, El Nino and La Nina-Walker circulation, Indian Dipole mode (IOD).

3. **Geological Oceanography of the Bay of Bengal:** The shelf, slope, 90^0 East Ridge, Plate boundary, active subduction, passive margin, sediment budget.
Swatch of No Ground: Origin, geological characteristics, size and extent, sediment dynamics, water mass, importance.
Bengal deep sea fan: Extents, types, sediment types, sedimentary sequences
Paleo-environment of the Bay of Bengal: Methods of reconstruction, deep sea drill, core, oxygen isotope stage, sea level changes.

Off-shore islands: Formations, types, distribution and recording, characteristics St. Martin Island: Geology and formation, morphology, ecology, sustainable management.

4. **Chemical Oceanography of the Bay of Bengal:** Water chemistry, sediment chemistry, Horizontal and vertical profiles of nutrients (No_3, No_2, NH_4, Si), vertical profiles of O_2, CO_2, Bio-geo-chemistry of the Bay of Bengal.

5. **Biological Oceanography of the Bay of Bengal:** Mixed layer depth, photosynthesis, chlorophyll concentration, primary production, secondary production, phytoplankton, zooplankton, benthos, fisheries production

6. **Satellite Oceanography of the Bay of Bengal:** Sea Surface Temperature (SST), Water circulation of the Bay of Bengal, chlorophyll concentration.

7. Geopolitics of Bay of Bengal: Geo-political importance of Bay of Bengal, Case study: Bangladesh Myanmar maritime boundary conflict and verdict.

8. **Living and Non-living ocean resources**: Resources Exploitation, Oceanographic factors involved in resource conservation and utilization, Energy from the sea –Wind, tidal, wave and thermal energy,

9. **Bay of Bengal Trades**: Major ports, Commodities of Trade, Modes of freight transport and major freight carriers, Rise and fall of routes, Trading center and modes of transport, Deep sea port.

Recommended Text(s):

1. Seibold, E, & Berger, W. H: The sea Floor, An Introduction to Marine Geology (3rd Ed).Erickson &Timbthy (2002); Marine Geology
2. The Ocean Basins: Their Structure and Evolution (second edition), Open University, ISBN 0750639830
3. The Sea Floor ---- An Introduction to Marine Geology (third edition), E. Seibold and W. ll. Berger. ISBN 3540601910
4. Marine Biogeochemical Cycles (second edition), Open University.
5. Marine Geochemistry, 11.D. Schulz and M. Zabel (cds.). ISBN 354066453X
6. Carol M Lalli& Timothy Parsons (1997) Biological Oceanography: An Introduction, 2nd edition. Butterworth-Heinemann Publishers. ISBN 0750633840.
7. Regional Oceanography: Tomczak M. &J.S.Godfrey, Daya Publishing House, New Delhi, 2004.
8. Remote Sensing of the Changing Oceans, Dan Ling Tang, Gad Levy, Malcolm Heron,James Gower, Kristina B. Katsaros and Ramesh Singh, Springer;2011

COURSE CURRICULUM

NUMERICAL TECHNIQUES FOR OCEANOGRAPHERS

Course Code : **OCN 1205**
Credits : 3.0

Objective:

To provide rapid communication between those interested in ocean modeling, whether through direct observation, or through analytical, numerical or laboratory models and including interactions between physical and biogeochemical or biological phenomena.

Syllabus Contents:

1. **Introduction:** Review and classification of different ocean models, Review of physical oceanography properties, The equation of state used in different ocean models, Review of terms used in modeling (vorticity, stream function, etc.)
2. **Equations and approximations :** Review of the equations of motion (Primitive Equations Models), Common assumptions and their impact (Hydrostatic, Boussinesq)
3. **Parameterization of mixing in ocean models:** Horizontal and vertical diffusion & viscosity, Turbulence schemes & mixed layer models
4. **Finite differencing and grid choices:** Basic finite differencing schemes and stability analysis, Staggered grids and their impact, Time split techniques and their effect on model efficiency, Horizontal grids (rectangular, curvilinear, triangular, unstructured)
5. **Quasi-Geostrophic and Shallow-Water models**
6. **Classification of ocean models by vertical grid choices:** Z-level models and the BBL problem, Isopycnal and layer models from simple 1.5 L reduce-gravity models to global hybrid models, Terrain-following/Sigma-coordinate models
7. **Boundary Conditions:** Sea-bed/bottom boundary conditions and sediments, Surface boundary conditions and air-sea exchange, Lateral/coastal boundary conditions, Special cases: rivers, wetting and drying, Open boundary conditions, Radiation conditions, cyclical, buffer zones, Tides

Recommended Text(s):

1. Mathematical Methods for Oceanographers: An Introduction Edward A. Laws
2. Data Analysis Methods in Physical Oceanography: William J. Emery, Richard E. Thomson
3. Haidvogel and Beckmann, Numerical Ocean Circulation Modeling, Imperial College Press, 1999.
4. Kantha and Clayson, Numerical Models of Oceans and Oceanic Processes, Academic Press, 2000.
5. Griffies, Fundamentals of ocean climate models, Princeton Univ. Press, 2004.
6. Mooers (Ed.), Coastal Ocean Prediction, Coastal & Estuarine Studies Ser., 56, AGU Publ., 1999.

7. Pinardi and Woods (Eds.), Ocean Forecasting: Conceptual Basis and Applications, Springer, 2002.
8. O'Brien, J.J, Advanced Physical Oceanographic Numerical Modelling, Springer Publ., 1986.
9. Flannery, Teukolsky and Vetterling, Numerical Recipes in FORTRAN: The Art of Scientific Computing, H.W. Press, 1992.

COMPUTER PROGRAMMING FOR OCEANOGRAPHER

Course Code : **OCN 1207**
Credits : 3.0

Objective:

To be able to define a problem, plan a solution, code the program, test the program and finally to document the program.

Syllabus 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, essential file and printing services
   2.2 Application software
      (a) Definition, major types
      (b) Case types: Word processing, Worksheet management, Database management, Presentation graphics, Image/photo editing, Statistical package, Internet clients (mail, web, telnet, ftp)
      (c) 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.

1. **Programming with Fortran/C/C++:** Algorithm, Flow chart, Editor, Compiler and Interpreter, Elements of programming: constants, variables, data types, operators, expression, simple input/output programs, control statement, array, function/subroutines, files, Examples of development of oceanography programme.
2. **Programming with Ferret, MatLab etc**

Recommended Text(s):

1. Introduction to Computer Science and BASIC programming, by S Jain. BPB Publications, India.
2. FORTRAN, by Thomas R. Hoffman

3. Programming with C, by Byron S. Gottfried

COMPUTER PROGRAMMING FOR OCEANOGRAPHER (LAB)

Course Code : **OCN 1208**
Credits : **1.5**

Objective:

To understand all aspects of ocean modeling and data analysis.

Syllabus Contents:

1. Using OS: File and printing services
2. Word processing using Microsoft Word
3. Spreadsheet exercises using Microsoft Excel and selected software for graphics
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. Exercises in writing simple programs in BASIC and programming related with Fortran, Ferret, MatLab etc.
9. Submission of projects/reports on preparing different graphs and plots

PHYSICAL OCEANOGRAPHY

Course Code : **OCN 1209**
Credits : 3.0

Objective:

To understand the evolving patterns of ocean currents and water properties such as temperature, salinity, dissolved observations oxygen and to explore the roles of ocean circulation in the earth's eco-systems.

Syllabus Contents:

1. History of Oceanography

2. Physical properties of sea water
   2.1 Pressure and depth, units, accuracy and precision
   2.2 Temperature, heat and potential temperature
   2.3 Concept of salinity
   2.4 Electrical conductivity
   2.5 Density, potential density and neutral density, TS diagram

2.6 Distribution of temperature, salinity, conductivity, pressure etc. in ocean: Surface distribution, Vertical distribution and profiles, Meridional distribution

3. Sound and light in sea water: Propagation, attenuation, extinction, color of sea

4. Freezing, Sea Ice and ice bergs
   4.1 Freezing point and temperature of maximum density, effect of salinity, freezing in shallow seas and lakes, properties of sea ice

5. Water, salt and heat budget and flux
   5.1 Hydrologic cycle
   5.2 Conservation of Mass, Salt and Energy
   5.3 Heat fluxes and heat balance

6. Ocean Wave
   6.1 Wave parameters, Spectrum of surface waves
   6.2 Classification of waves
   6.3 Wind waves and swells
   6.4 Wave theories: Small amplitude wave theory
   6.5 Wave refraction, defraction, reflection
   6.6 Rossby wave and Kelvin wave

7. Ocean circulation
   7.1 Wind driven surface circulation: wind stress, Coriolis force, Ekman's spiral and net transport, major ocean currents
   7.2 Vertical circulation: Upwelling and sinking
   7.3 IOD

8. Astronomical Tides
   8.1 Causes of tide: centrifugal force and gravitational attraction, tidal potential
   8.2 Effects of sun-moon system on tide: distance, declination and nutation, diurnal inequality
   8.3 Types of tide
   8.4 Tidal datums

9. Dynamics of physical Oceanography
   9.1 Classification of forces and types of motion in the sea
   9.2 Kinematics of fluid flow, equation of continuity and applications
   9.3 Equation of motion in oceanography

Recommended Text(s):

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.

PHYSICAL OCEANOGRAPHY (LAB)

Course Code : **OCN 1210**
Credits : 1.5

Objective:

To study the movements of the oceans, in the waves and currents and tides that move the water itself.

Syllabus Contents:

1. Measurement of seawater properties: Salinity, Electrical Conductivity, Density
2. Calculation of various water properties from known parameters: Salinity, EC, Density, 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

CHEMICAL OCEANOGRAPHY

Course Code : **OCN 2101**
Credits : 3.0

Objective:

To investigate the complex chemistry, distribution, and cycling of dissolved substances, nutrients, and gases in seawater, the mechanisms controlling them, and their origins and fates.

Syllabus 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. Geochemistry and marine environment
19. Chemical features of Indian Ocean and Bay of Bengal
20. Greenhouse gases and its effects in the Bay of Bengal

Recommended Text(s):

1. Marine Chemistry, by Martin.
2. Chemical Oceanography, by Horne.
3. Chemistry and fertility of sea water, by Harvey.
4. Aquatic Environmental Chemtry, 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.

CHEMICAL OCEANOGRAPHY (LAB)

Course Code : **OCN 2102**
Credits : **1.5**

Objective:

To understand sea water properties applying different quantitative analysis processes.

Syllabus 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 p^H, E^h, 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.

MARINE INVERTEBRATES

Course Code : **OCN 2103**
Credits : 3.0

Objective:

To learn what marine invertebrates are, how they are classified, how each is similar and different from ourselves and how each is connected to us.

Syllabus Contents:

1. Classification of marine invertebrates
   1.1 Identification
   1.2 Classification
   1.3 Taxonomy

2. Salient features of major invertebrates

3. Study of different phyla of marine invertebrates
   3.1 External characteristics
   3.2 Internal characteristics

4. Anatomy of major marine invertebrates
   4.1 Protozoa
   4.2 Porifera
   4.3 Coelenterate
   4.4 Ctenophore
   4.5 Rotifer
   4.6 Annelida
   4.7 Mollusca
   4.8 Arthropoda
   4.9 Echinodarmata

5. Organ systems of major marine invertebrates
   5.1 Digestive system
   5.2 Reproductive system
   5.3 Respiratory system
   5.4 Circulatory system
   5.5 Excretory system

6. Distributional pattern of major phyla in the marine environment

7. Ecology of different marine invertebrates

Recommended Text(s):

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

MARINE INVERTEBRATES (LAB)

Course Code : **OCN 2104**
Credits : **1.5**

Objective:

To get practical knowledge by going to the habitats where marine invertebrates live including tide pools, experimental aquaria, and the Birch Aquarium.

Syllabus Contents:

1. Collection, preservation and identification of invertebrates
2. Study of external morphological features of microscopic 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, mollusces, polychaetes etc.

MARINE VERTEBRATES

Course Code : **OCN 2105**
Credits : 3.0

Objective:

To offer a broad introduction to the characteristics and affinities of marine vertebrates: fish, reptiles, birds and mammals.

Syllabus Contents:

1. Introduction: The Science of Marine Biology, Fundamentals of Biology

2. **Marine Vertebrates**: (Marine fishes, Marine Reptiles, Sea birds, Cetaceans, Sirenians, Pinnipeds and Marine Otters). Evolutionary history of Marine Vertebrates; Classification, Identification, Habitat, Life cycle, Distribution, Locomotion, Feeding, Breeding and Reproduction, Importance and uses etc.
3. Cartilaginous Fishes
4. Shark, Bony Fishes, Marine Reptiles and Sea Birds, Marine Mammals
5. Molecular and Cellular Biology, physiology of marine vertebrates

Recommended Text(s):

1. Liem, KF, WE Bemis, WF Walker, L Grande. 2001. Functional Anatomy of the Vertebrates: An Evolutionary Perspective, 3rdEdition. Thomson/Brooks Cole, Belmont, CA.

2. Pough, FH, CM Janis, JB Heiser. 2012. Vertebrate Life, 9thEdition. Benjamin Cummings, San Francisco, CA

MARINE VERTEBRATES (LAB)

Course Code : **OCN 2106**
Credits : 1.5

Objective:

To examine the ecology of marine vertebrates with particular reference to feeding, reproduction, behavior and migrations.

Syllabus Contents:

1. Collection, preservation and identification of vertebrates
2. Study of external morphological features of marine vertebrates
3. Study of external and internal anatomy of higher marine vertebrates
4. Museum study of marine Vertebrates: Cartilaginous Fishes, Shark, Bony Fishes, Marine Reptiles and Sea Birds, Marine Mammals etc
5. Commercially important species of vertebrates (Report/presentation)

STATISTICAL TECHNIQUES FOR OCEANOGRAPHER

Course Code : **OCN 2107**
Credits : 3.0

Objective:

To examine the ecology of marine vertebrates with particular reference to feeding, reproduction, behaviour and migrations.

Syllabus Contents:

1. Definition, scope and importance of statistics in oceanography
2. Presentation of data.
   2.1 Introduction
   2.2 Types of data, tabulation of data, frequency and frequency distribution, construction of frequency distribution table
3. Graphical Representation
   3.1 Introduction of graph, types of graphs
4. Measures of Central Tendency
5. Measures of Dispersion
   5.1 Introduction, different types of dispersion
6. Moments, Skewness and Kurtosis
   6.1 Introduction, Definition and types of Skewness and Kurtosis, Absolute and relative measures of Skewness, Measures of Kurtosis, Use of Moments in Skewness and Kurtosis
7. Correlation and Regression
   7.1 Correlation: Coefficient of correlation, Simple correlation, Rank correlation, Coefficient of determination
   7.2 Regression: Regression coefficient, Simple regression, Multiple regression, Polynomial Regression
   7.3 Use of regression and correlation analysis: Limitations and Errors
8. Probability Distribution

8.1 Basic concept of probability, Related mathematics, Elementary Probability and Conditional probability

8.2 Probability distribution, Random variable & Expected value in Decision making

8.3 Properties, constants and significance of Binomial distribution, Poisson distribution and Normal distribution

9. Sampling

9.1 Introduction to sampling, population and sample, types of sampling- Judgment sampling and Probability sampling

9.2 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

10. Basic ideas of test

10.1 Introduction: hypothesis, null hypothesis, alternative hypothesis, label of significance, confidence limit

10.2 ‘t’ distribution, properties of ‘t’ distribution application of ‘t’ distribution, ‘t’ tests

10.3 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.

11. Experimental design

11.1 Introduction, Phases of experimental design

11.2 Randomized block design

11.3 The Latin squire design

12. Test of significance

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

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

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

14. Time series and forecasting

14.1 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

Recommended Text(s):

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, by Norman and Bailey, 1995
8. Biometry, by RR Sokal and FJ Rohlf, 1981

GEOLOGICAL OCEANOGRAPHY

Course Code : **OCN 2201**
Credits : 3.0

Objective:

To learn about the origin, structure and evolution of the ocean basins and their margins.

Syllabus Contents:

1. Introduction
   (a) Brief history of marine Geology and geological time scale
   (b) Early mapping, positioning and sampling techniques
2. General Geological and physiographic features of the Earth
   (a) Shape and dimension: hypsometry, relative distribution of land and sea
   (b) Continental drift and sea floor spreading: conceptual development, evidences, opposition
   (c) Tectonics as an explanation of major Earth features and processes
3. Physiographic features of the Ocean and Ocean basins
   (a) Large scale features: ridge, trench, fracture zone, fault, sea mount, island arc, a seismic ridge, abyssal hill, guyot, abyssal plain and others
   (b) Features associated with continental margin: terrace, shelf, slope, rise, depressions and others
   (c) Near shore and other features: Reef, coral island, atoll, sedimentary formations and others
4. Eustatic changes of sea level, causes and methods of study(Tsunamis, turbidity currents).
5. Earthquakes, volcanism and mountain building in the sea
6. Evolution of the Indian ocean floor.
7. Topography and sediments of the floor of the Bay of Bengal
8. Heavy minerals in the coastal beaches of Bangladesh
9. Deep sea deposits: brown clay, manganese nodule and oozes
10. Calcium carbonate and foraminifera deposition in the sea.

Recommended Text(s):

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.

GEOLOGICAL OCEANOGRAPHY (LAB)

Course Code : **OCN 2202**
Credits : 1.5

Objective:

To investigate Marine geological processes, ocean basin structure and tectonics by data collection, interpretation and analysis.

Syllabus Contents:

1. Preparation of Bathymetric charts and interpretation
2. Collection, separation and identification of heavy minerals and sediment
3. Deep sea sediment analyses, manganese nodule and foraminifera collection and identification.
4. Preparation and interpretation of sediment maps and triangle coordinate diagram from analytical data.

FISHERIES OCEANOGRAPHY

Course Code : **OCN 2203**
Credits : 3.0

Objective:

To deliver quality education and conduct cutting-edge research in the interdisciplinary sciences related to the interactions between marine organisms and the marine environment.

Syllabus 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. **Fishery technology**: Preservation and processing in Bangladesh; fishery by products, export of marine products.

9. **Climate variability and fisheries ecosystems**: Global climate change, climate and the geography of the sea; decadual oscillations in the Bay of Bengal: Hilsa, Sharks and Tuna fish.

10. FAO code of conduct for responsible fisheries and Marine fisheries ordinance of Bangladesh.

Recommended Text(s):

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.

FISHERIES OCEANOGRAPHY (LAB)

Course Code : **OCN 2204**
Credits : 1.5

Objective:

To get idea about fish behavior and biology by quantitative assessment methods.

Syllabus Contents:

1. Identification of fishes, crustaceans and mollusks
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.

BIOLOGICAL OCEANOGRAPHY

Course Code : **OCN 2205**
Credits : 3.0

Objective:

To know about the factors governing productivity, population dynamics and distribution of organisms in major ecosystems of the ocean.

Syllabus 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
5. Culture of phytoplankton and zooplankton
6. Migration of Plankton
7. Plankton collecting gears
8. Phytoplankton bloom
9. Blast water plankton
10. Plankton and oil formation in the sea

Benthos

11. General concept and importance of benthos in the ocean
12. Benthic communities and their distribution of seafloor
13. Benthic flora and fauna and their vertical stratification, aerobic and anaerobic organisms

Coral Reefs

14. Mechanism of coral formation
15. Ecology, types and distribution of coral reef
16. Coral reef and their relation to flora and fauna
17. Coral destruction and exploration

Mangroves

18. Mangrove plantation, deforestation and forest conservation in the marine environment
19. Mangrove biodiversity, productivity and fertility in the sea

Marine aquarium and park organisms

20. Classification, Ecology and distribution of aquarium and park organisms
21. Breeding and nursing of aquarium and park organisms
22. Teaching methods of aquarium organisms
23. Engineering, operation and management of aquarium organisms.

Recommended Text(s):

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

BIOLOGICAL OCEANOGRAPHY (LAB)

Course Code : **OCN 2206**
Credits : 1.5

Objective:

To examine the processes governing the distribution, abundances, and production of plants, animals, and nutrients in the oceanic ecosystem.

Syllabus Contents:

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

LAW OF THE SEA

Course Code : **OCN 2207**
Credits : 3.0

Objective:

To broaden the traditional approach to the Law of the Sea from jurisdictional issues to include substantial law such as conservation and sustainable use of biological resources and protection of biodiversity and the environment.

Syllabus Contents:

1. **Introduction to the Law of the Sea**: Concept, Evolution, U.N. Conferences and Conventions
   - 1.1 History of the law of the sea
   - 1.2 Concept and evolution of the law of the sea
   - 1.3 The United Nations Conferences and Conventions
   - 1.4 UNCLOS
   - 1.5 The U.N. Law of the Sea Convention 1982

2. A. **Maritime Territory**:
   - 2.1 The legal regime of the internal waters and of the territorial waters
   - 2.2 Straight base lines
   - 2.3 Bays
   - 2,4 Bays bordered by more than one state
   - 2.5 Internal waters
   - 2.6 The Legal regime of ports
   - 2.7 Jurisdiction in internal waters

2. B. **Territorial Sea:**
   - 2.1 The competences of the coastal State
   - 2.2 Innocent passage
   - 2.3 Competences of the coastal State concerning fisheries
   - 2.4 Competences concerning security and defense
   - 2.5 Competences concerning customs and fiscal regulations
   - 2.6 Competences concerning sanitary control
   - 2.7 Competences concerning navigation
   - 2.8 Competences concerning the exploration and exploitation of the seabed and its subsoil
   - 2.9 Competences over the superjacent air.

3. A. **Functional Marine Zones:**
   3.1 The contiguous zone
   3.2 Other functional marine zones
   3.3 Fishery zones

3. B. **Implications of the EEZ:**
   3.1 The EEZ and its legal implications
   3.2 Right of the Coastal states
   3.3 Rights that all states have in the EEZ
   3.4 Delimitation principles

4. The Legal regime of the continental shelf
   4.1 The legal concept on continental shelf
   4.2 Delimitation of the continental shelf between opposite and adjacent states
   4.3 The right of the coastal state

5. The legal regime of the Deep sea bed
   5.1 General concept on deep sea bed
   5.2 The natural resources of the deep sea bed
   5.3 The legal regime for the deep sea bed
   5.4 The international Sea Bed Authority
   5.5 The exploitation principles for deep sea sining
   5.6 The review conference (PIP, PREPCOM, Unilateral regulations for deep sea mining.

6. **The Legal regime of the high seas:**
   6.1 Freedom of the high seas
   6.2 The freedom of the navigation
   6.3 The Freedom of the fisheries
   6.4 The freedom to lay submarine cables and pipe lines
   6.5 The freedom of over flight
   6.6 The freedom of scientific research
   6.7 Freedom to construct artificial Islands and other instalations
   6.8 Jurisdiction on the high seas

7. **Legal Fisheries Regime:**
   7.1 Background to the International Law of Fisheries
   7.2 International Law of Fisheries

8. **Marine Pollution Legal Regulation:**
   8.1 The concept of Marine Pollution
   8.2 General principles of international law relating to marine pollution
   8.3 Pollution from ships
   8.4 Liability for pollution damage
   8.5 Pollution resulting from dumping
   8.6 Pollution from sea bed activities
   8.7 Land based sources of marine pollution
   8.8 Atmospheric pollution.

9. **Marine Scientific Research**: Legal problems and Solution
   9.1 The Geneva Rules

9.2 The Law of the Sea convention
9.3 Research installation.

Recommended Text(s):

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

MARINE PLANKTOLOGY

Course Code : **OCN 2209**
Credits : 3.0

Objective:

To develop broad knowledge and interests to construct holistic picture of biological processes and production in the ocean.

Syllabus Contents:

1. Definition, classification and importance of 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 *Skeletonemacostatum*, 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 Text(s):

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 Spoelet at, 1979

MARINE PLANKTOLOGY (LAB)

Course Code : **OCN 2210**
Credits : **1.5**

Objective:

To be able to identify and estimate the no. of planktons over a specific region by determination of different properties.

Syllabus Contents:

1. Preparation and handling of plankton collection equipments.
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

SEDIMENTOLOGY

Course Code : **OCN 3101**
Credits : 3.0

Objective:

To learn the physics of the fluids, Hydrodynamics, Open channel flows, Sediment movement, Sediment transport and deposition in the Bay of Bengal.

Syllabus Contents:

1. The physics of the fluids:
   1.1 Fluid properties, fluid statics, pressure variations, hydrostatic force (curve & plane surface), buoyancy.
2. Hydrodynamics:

2.1 Types of flow, continuity equation, equation of motion, momentum equation, real fluid flow, energy losses.

3. Open channel flows:

3.1 Type of channel: non-uniform flow, gradually varied flow, unsteady non-uniform flow.

3.2 Steady uniform flow, boundary layer and boundary roughness, velocity distribution, bed shears and shear velocity.

3.3 Secondary flow, resistance equation.

4. Sediment movement:

4.1 Sediment properties, viscosity of the dilute suspensions, fall velocity, initiation of movement, bed forms influences ripples and dunes

5. Bed forms and bed roughness:

5.1 Types of bed forms, dimensions of bed forms, effective bed roughness.

6. Sediment transport:

6.1 Modes of particle motion, types of load: bed load transport and suspended load transport, total load transport, transport measurements.

6.2 Sediment transport and deposition in the Bay of Bengal.

6.3 Marine Sedimentary and Environmental Evolution.

Recommended Text(s):

1. Acheson, D.J. (1992) Elementary Fluid Dynamics. Oxford University Press. ISBN 019 8596790.
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.

SEDIMENTOLOGY (LAB)

Course Code : **OCN 3102**
Credits : 1.5

Objective:

To learn Flow observation, Flow measurement, Sediment movement, Bed form observation, Field observation: Erosion-deposition characterization of the tidal flat, Preparation of bathymetric charts and interpretation, Measurement of sediment movement through proper experimental instrumentation.

Syllabus Contents:

1. Flow observation: Open channel flow, Hydraulic jump, Flow distribution
2. Flow measurement: use of current meter in natural conditions, construction of velocity graphs
3. Sediment movement: Initiation of movement, justification of erosion and stable condition
4. Bed form observation: Different structures in the channel floor, roughness
5. Field observation: Erosion-deposition characterization of the tidal flat

6. Preparation of bathymetric charts and interpretation.
7. Measurement of sediment movement.

OCEANOGRAPHIC INSTRUMENT

Course Code : **OCN 3103**
Credits : 3.0

Objective:
To learn the operational method of pH meter, Centrifugation, Microscope, Chromatography, Electrophoresis, Flame photometry and Atomic absorption spectroscopy, Isotope techniques, Spectroscopy etc.

Syllabus Contents:

1. pH meter, Salinometer, Oxygen analyzer, Lux meter, Potentiometeric titrations, Staining techniques – Chemistry and sections of stains – micro technique.

2. Centrifugation – Principles and applications of preparative and analytical ultracentrifuges; high speed centrifuges.

3. Microscopy – Simple microscope, compound microscope, phase contract microscope; fluorescence microscope; Electron microscope – principles and applications.

4. Chromatography – Adsorption, partition and ion exchange chromatography; Gas chromatography – Principles and applications.

5. Electrophoresis – Gel electrophoresis; paper electrophoresis – Principles and applications.

6. Flame photometry and Atomic absorption spectroscopy – Principles and applications.

7. Isotope techniques – Principles and applications of GM counter; Scintillation Counter' use of radioactive isotopes in biological studies; Ionizing radiation.

8. Spectroscopy – Simple colorimetric; UV – Visible absorption spectroscopy; Fluorescence spectroscopy; Infrared spectroscopy – Principles and applications.

9. Winches, Reversing water bottle, Reversing thermometer, Bathy thermography, Current meters, Secchi disc, dredges, Tide gauges, underwater photography, Echo sounder, Floating wave recorders, telemetering instruments.

10. Radar and Satellite – Principles, types, uses, limitations.

11. A survey vessel study for hydraulics measurements.

12. PCR machine-marine biotechnology and molecular biology

13. Water bath-Chlorophyll measurement and other experiment

14. Autoclave machine-sterilization of the glass wares and plastic (temperature and pressure controlling)

Recommended Text(s):

1. Coastal Hydraulics, A.M. Muir Wood.
2. The Practical use methods of Analysis, Willard, Marrit and Dean.
3. The Practical use of the Microscope, G.H. Needham.

METEOROLOGY AND OCEAN FORECASTING

Course Code : **OCN 3105**
Credits : 3.0

Objective:
To learn basic meteorology, Air-Mass, Atmospheric Circulation, Fronts and Frontal disturbances, World weather types, Weather Forecasting, Climatology of Bangladesh and adjacent Bay of Bengal, Air-Ocean Interaction, Ocean and Climate Observation.

Syllabus 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 vapour; Clouds and rainfall and 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. Air-Ocean Interaction.

11. Ocean and Climate Observation

Recommended Text(s):

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.

SEISMOLOGY AND HYDROCARBON EXPLORATION

Course Code : **OCN 3107**
Credits : 3.0

Objective:

To learn classification of mineral resources of the sea, Minerals of the deep sea floor, The occurrence of petroleum and other hydrocarbon, Migration and accumulation of petroleum, Seismic techniques, Offshore Exploration, Seafloor Probing & Information Techniques, Deep Sea Mineralization and Resources Detection.

Syllabus 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 future prospects
   - 2.6 Petroleum and gas from the continental margins of Bangladesh
3. The occurrence of petroleum and other 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, Palaegeographic 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. Seismic techniques – data acquisition, data processing, stratigraphic studies seismic facies parameters, formation and density, velocities of gas bearing sands tones. migration, pitfalls in structure interpretation.
8. Hydrocarbon detectability, seismic resolution
   8.1 The delineation of reservoirs
   8.2 The main indications of reservoirs – mud filtrate invasion.
9. Offshore Exploration:
   9.1 Positioning in the sea
   9.2 Echo sounding and scanned sonar methods
   9.3 Offshore mining
10 10.1 Seafloor Probing & Information Techniques
   10.2 Deep Sea Mineralization and Resources Detection

Recommended Text(s):

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

ENVIRONMENTAL IMPACT ASSESSMENT

Course Code : **OCN 3109**
Credits : 3.0

Objective:

To learn and assess Green-house gases, Water Pollution, Sewage, Industrial Wastes, Heavy Metals, Agro-Chemicals, Oil Pollution, Marine Pollution conventions and Law of the sea to control marine pollution.

Syllabus Contents:

1. **Introduction**
   1.1 Definition of pollution, types, contamination and sources of pollution in the coastal and deep sea, effect of pollutants on marine organisms
   1.2 Green-house gases: sources, effect on global warming and sea-level changes
   1.3 Natural and anthropogenic sources of marine pollutants; Significance of pollutants and their reactions in the atmosphere
   1.4 Transport and dispersion of marine pollutants – effects of meteorological and topographic functions. Effects of pollutants; sampling of gaseous and particulate pollutants – their analysis and control

2. **Water Pollution**: 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**: 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**: 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**: Introduction, Sources of heavy metals, Effects of heavy metals on aquatic ecosystem. Bioaccumulation and biomagnification of lead, cadmium, chromium & mercury

6. **Agro-Chemicals**: 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**: 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. Marine Pollution conventions and Law of the sea to control marine pollution.

Recommended Text(s):

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. River Pollution–an Ecology Perspective, by SM Haslam. CBS Pub. & Distributor. New Delhi.1990.
8. Standard Methods for the Examination of Water & Wastewater, by APHA . Washington. D.C.1996.

PALEONTOLOGY

Course Code : **OCN 3111**
Credits : 3.0

Objective:

To learn Indiana Geological Survey, A Short history of life, introduction to metazoan phyla, Ordovician, Silurian And Devonian, Mississippian, Carboniferous Carbonates in Indian, Evolution, Phylogeny, and Taxonomy.

Syllabus Contents:

1. Introduction, Indiana Today, A short history of North America
2. Where do Indiana's rocks come from?, Overview of Indiana Geology
3. Indiana Geological Survey, A Short history of life
4. Introduction to metazoan phyla, Ordovician: The Cincinnatian And the Richmondian invasion, Climate And Isotopes In the Ordovician
5. Silurian And Devonian: Colonization of the land
6. Mississippian: The Borden Delta, Mississippian: Sun, seas, and reefs
7. Carboniferous Carbonates in Indiana
8. Pennsylvanian: Climate Gone wild
9. Evolution, Phylogeny, and Taxonomy
10. Industry in Indiana: Stone, Coal and oil, Coal
11. Biostratigraphy, Correlation, and Extinction
12. What We miss: Mesozoic and Cenozoic
13. Quaternary Environments and glacial cycles
14. People Come to Indiana and the Late Pleistocene Extinction
15. Paleo-indians And the White River Valley, Back to the present, and the future

Recommended Text(s):

1. Camp, M.J. and G.T. Richardson. 1999. *Roadside Geology of Indiana.* Mountain Press Publishing Company. 315 pp. ISBN-13: 978-0878423965.
2. Feldmann, R.M. and M. Hackathorn (eds). 1996 (rev. 2005). *Fossils of Ohio*. Bulletin of the Ohio Department of Natural Resources Division of Geological Survey Number 70. 577 pp. ISBN-13: 978-0931079054.
3. Thompson, T.A. and K.H. Sowder. 2010. *Generalized Stratigraphic Column of Indiana Bedrock*. Indiana Geological Survey Poster 06A.

GEOPHYSICAL FLUID DYNAMICS

Course Code : **OCN 3201**
Credits : 3.0

Objective:

To learn Marine Geophysics, Seabed imaging by Sonar and Lidar, Seismic Exploration at sea, Marine Gravity Field, Heat Flow, Global heat flow, Geophysical methods, Marine Geological Applications.

Syllabus Contents:

1. Introduction to Marine Geophysics:
   1.1 Historical development
   1.2 Definition, scope, importance, limitation of marine Geophysics
   1.3 Locating offshore observations

2. Seabed imaging by Sonar and Lidar:
   2.1 Single beam echo-sounding
   2.2 Swath Mapping
   2.3 Side scan Sonar
   2.4 Multi beam sounding
3. Seismic Exploration at sea:
   3.1 Propagation of seismic waves
   3.2 Seismic refraction method
   3.3 Seismic reflection method
   3.4 Seismic data acquisition at sea
   3.5 Profiling algorithm
4. Marine Gravity Field:
   4.1 Early gravity measurement in the sea
   4.2 Gravimeters
   4.3 Calculation of gravity anomalies
   4.4 Areal and Satellite measurement
5. The Earth's Magnetic Field at sea
   5.1 The geomagnetic field
   5.2 Magnetic field measurements over the sea
   5.3 Total –field magnetic anomalies
   5.4 Magnetics of rocks and sediments
6. Heat Flow:
   6.1 Global heat flow
   6.2 Measurement of heat flow of sea
   6.3 Heat transfer and surface heat flow
   6.4 Influence of heat flow at local scales
   6.5 Regional heat flow variation
7. Other Geophysical methods
   7.1 Investigations of the Sea floor using Electrical Methods.
   7.2 Seabed Exploration using Radiometric Methods
   7.3 Geophysical observations in offshore Boreholes
8. Marine Geological Applications
   8.1 Deep sea Geophysics and the changing Geometry of the ocean
   8.2 Studies of the Oceanic Lithosphere: The Sedimentary Cover.
   8.3 Studies of the Oceanic Lithosphere: The Crustal Basement and Upper Marine
   8.4 Investigations of Divergent and Transform Continental Margins
   8.5 Studies of Subduction Zones.
9. 9.1 Marine Geophysical Field and Lithospheric Dynamics.

Recommended Text(s):

1. Marine Geophysics, 1999, E. J. W. Jones.
2. Exploration Seismology, 1995., R.E. Sheriff and L.P. Geldart.
3. Applied Geophysics,1990, W.M. Telford, L.P. Geldart and R.E. Sheriff.
4. Principles and Applied Geophysics, D.S. Parasnis.

COURSE CURRICULUM

SEAMANSHIP AND NAVIGATION

Course Code : **OCN 3203**
Credits : 3.0

Objective:

To learn general information on Seamanship and Navigation, Parts of the ship, navigational instruments, Buoyage, Tides, Electronic Navigation, Rules of the Road, Fire Fighting.

Syllabus 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, Azimuth mirror, Magnetic compass, Gyro compass, 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.

Recommended Text(s):

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 IvarDedekam, Wiley Nautical, 2007, 91 pp.
4. The American Practical Navigator: Bowditch, by Nathaniel Bowditch, 2002, 296 pp.

COURSE CURRICULUM

HYDROGRAPHY

Course Code : **OCN 3205**
Credits : 3.0

Objective:
To get idea about the measurement, description, and mapping of the surface waters of the earth, with special reference to their use for navigation.

Syllabus 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 aids ti navigation positioning,
Remote sensing tools used for topographic surveying
10. Hydrographic practice: Hydrographic survey planning, survey reconnaissance, data acquisition, coastline 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

HYDROGRAPHY (LAB)

Course Code : **OCN 3206**
Credits : 1.5

Objective:

To learn measurement of tides for sea coast work, determination of bed depth by data collection, recording and analysis.

Syllabus 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. Tide calculation
4. Horizontal and vertical control methods of hydrography

MARINE BIOGEOCHEMISTRY

Course Code : **OCN 3207**
Credits : 3.0

Objective:

To get idea about the complex biological, chemical, and physical processes involved in the cycling of key chemical elements within the ocean, and between the ocean and the seafloor, land and atmosphere.

Syllabus Contents:

1. A historical sketch of biogeochemical cycles
2. Cycles of major elements in the deep ocean
3. Mass balance between river input and oceanic sediment outputs for minor and trace elements
4. Biogeochemical cycles of carbon and sulfur
   - 4.1 The carbon cycle
   - 4.2 The sulfur cycle
   - 4.3 Isotope fractionations in the geochemical cycles of carbon and sulfur
   - 4.4 Relations among isotope age curves
   - 4.5 Long term evolution of the biogeochemical cycles of the Earth,
5. Si, P and Fe biogeochemical cycles
6. Primary production in the ocean: nutrient supply, primary producers, seasonal cycles, spring bloom, nitrogen fixation
7. Redfield ratio
8. Air-sea carbon dioxide fluxes
9. Climate change feedbacks on C - cycle
10. Ocean acidification and carbonate chemistry.
11. Benthic processes of biogeochemical cycles.

Recommended Text(s):

1. An Introduction to Marine Biogeochemistry, M. Susan.
2. Chemical Cycles in the Evolution of the Earth, C. B. Gregor, R.M. Garrels, F.T. Mackenzie and J. B. Maynard.

MARINE MICROBIOLOGY

Course Code : **OCN 3209**
Credits : 3.0

Objective:

To get acquainted with marine microorganisms and learning microbial processes of environmental and geochemical significance.

Syllabus 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 sulfur 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. Ocean acidification and rapid changes in ocean chemistry.
9. Economic importance and application of micro-organisms in Oceanography

Recommended Text(s):

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

MARINE MICROBIOLOGY (LAB)

Course Code : **OCN 3210**
Credits : 3.0

Objective:

To provide detailed information on the most up to date methods for the study of microbial communities through analysis of microbial datasets.

Syllabus 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.

ACOUSTICAL OCEANOGRAPHY

Course Code : **OCN 3211**
Credits : 3.0

Objective:

To provide with an understanding of the physical processes that occur in the oceans and the effects they have on the propagation of underwater sound.

Syllabus Contents:

1. Fundamentals, Simple propagation, Rays, sources and receivers, radiated sound
2. Bioacoustics, Waveguides, scattering by bubbles, Shadow zone
3. Interior fluctuations and rough surfaces, The near surface ocean: upper ocean boundary layer and rain Bioacoustics
4. Sensing of plankton and nekton, Passive acoustics and marine animals
5. Marine mammals Ocean Dynamics: tomography, Time reversal
6. Turbulence Ocean Bottom: imaging hydrothermal vents
7. Large scale mapping Other topics: noise from pile driving, Ocean energy devices
8. Computational Ocean Acoustics
9. Plane, cylindrical and spherical wave propagation
10. understanding an Acoustic Doppler Current Profiler (ADCP),

Recommended Text(s):

1. Sound in the Sea, Medwin, Cambridge University Press, 2005
2. Principles of Sonar Performance Modeling, Ainslie, Springer, 2010
3. Underwater Acoustics: Analysis, Design and Performance of Sonar, Hodges, Wiley, 2010
4. Inverse Problems in Underwater Acoustics, Taroudakis and Makrakis, Springer, 2001
5. Fundamentals of Acoustical Oceanography, Medwin and Clay, Associated Press, 1998
6. Ocean Acoustic Tomography, Munk, Worcester, and Wunsch, Cambridge University Press, 1995

7. Oceanography and Acoustics: Prediction and Propagation Models, Robinson and Lee, American Institute of Physics, 1994
8. The Sonar of Dolphins, Au, Springer-Verlag, 1993

RESEARCH METHODOLOGY

Course Code : **OCN 4101**
Credits : 3.0

Objective:

To be able to identify a research problem stated in a study and acquire knowledge about the overall process of designing a research study from its inception to its report.

Syllabus 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).

Recommended Text(s):

1. Research methods in marine biology, edited by C Schliepen, 1968
2. How to write scientific papers, Elsevier, 1965

3. Research Methodology Methods and Techniques, C. R. Kothari.
4. A guide to Research Proposal and Report Writing, A. R. Moten.

SATELLITE OCEANOGRAPHY

Course Code : **OCN 4103**
Credits : 3.0

Objective:

To encompass oceanographic research and technological development resulting from manned and unmanned systems in Earth's orbit to observe and measure oceanographic parameters such as seas surface winds, sea surface temperature, waves, ocean currents and frontal regions.

Syllabus 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 Further analysis
   3.8 Spatial Information Network and Ocean Monitoring.
   3.9 Remote Sensing on Island and Coastal Zone.
   4.0 Interface Processes and Microwave Remote Sensing.

Case Applications

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

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

Recommended Text(s):

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

11. Datums and Map Projections for Remote Sensing, GIS and Surveying. By J Iliffe. Whittles Publishing.150pp. 2000.
12. Remote Sensing and Image Interpretation, 3rd Ed. by TM Lillesand and RW Kieber. John Willey &Sons. 1994

COASTAL AND MARINE POLLUTION

Course Code : **OCN 4105**
Credits : 3.0

Objective:

To explain the different types of negative anthropogenic impacts on the global oceans including physical, chemical and biological processes and characterize sources and effects of pollutants on the marine environment.

Syllabus Contents:

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. Air Pollution
1.1 Definition, major sources of air pollution, effect of air pollution on human beings. Greenhouse gases: sources, effect on global warming and sea-level changes
1.2 Atmosphere and its function: Gas laws governing the behaviour of pollutants in atmosphere. Natural and anthropogenic sources of atmospheric pollutants; Significance of pollutants and their reactions in the atmosphere
1.3 Transport and dispersion of pollutants – effects of meteorological and topographic functions. Effects of pollutants; sampling of gaseous and particulate pollutants – their analysis and control. Air quality standards and criteria
3. Water Pollution
3.1 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
4. Sewage
4.1 Definition of sewage, sources and types of sewage, Characteristics of sewage, Sewage treatment, Eutrophication and its effect. Solid waste disposal problem and itsmanagement 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 bio-magnification 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 biomagnifications of organ chlorine 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

Recommended Texts:

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. River Pollution–an Ecology Perspective, by SM Haslam. CBS Pub. & Distributor. New Delhi.
1990.
8. Standard Methods for the Examination of Water & Wastewater, by APHA. Washington. D.C.
1996.

COASTAL AND MARINE POLLUTION (LAB)

Course Code : **OCN 4106**
Credits : 1.5

Objective:

To characterize extent of pollutants on the marine environment by different Physiochemical and biological tests.

Syllabus Contents:

1. Assessment of Physio-chemical condition: DO, BOD5, COD, pH, S‰. Nutrients, Organic matter
2. Spectrophotometric analysis of organic and inorganic matters in water
3. Selected biological methods for the assessment of marine pollution; Bioassay test on shrimp,
Mollusca and fish
4. Physicochemical & Biological test of water quality
5. Determination of some trace elements
6. Determination of benthos from polluted area
7. Comparative study of organisms between polluted and unpolluted areas
8. Determination of Lethal Concentration/Dosage (LC50/LD50)

COURSE CURRICULUM

MARINE ECOSYSTEM MODELING

Course Code : **OCN 4107**
Credits : 3.0

Objective:

To present basic and robust ecological models that are able to take into account the effects of disturbances on marine ecosystems dynamics and oceans' biodiversity, and that are able to forecast recoveries when disturbances stop or mostly when conservation methods are implemented.

Syllabus Contents:

1. General concept of modeling
   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. Modeling Techniques
   3.1 Ordinary differential equations
   3.2 Numerical modeling
   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 modeling for oceanography data
   5.1 Probability distribution
   5.2 Least square and regression model, goodness of fit, linear and non linear least square techniques
   5.3 Principle component sand factor analysis 1 & 2
   5.4 Time Series analysis.
6. Telemetry Technique and Ocean Model

7. Box model, 2 dimensional and 3 dimensional model, Physical, biological, ecological, bio-geo-chemical and ecosystem model of the Bay of Bengal. Storm surge modeling

Recommended Text(s):

1. Modeling Methods for Marine Science, Glover, Jenkins and Deney.

2. Applied Factor Analysis in the Natural Sciences, Reyment and Joreskog.
3. Regional Ocean Modeling System(ROMS) NPZD, Gruber et al,2006.
4. Water and water pollution handbook, Vol 1, L.L. Claccio.

MARINE ECOSYSTEM MODELING (LAB)

Course Code : **OCN 4108**
Credits : 1.5

Objective:

To understand the structure, functioning and interactions of the ecosystem or sub-system, under consideration by statistical analysis and numerical modeling.

Syllabus 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.

DATA COLLECTION & ANALYSIS IN OCEANOGRAPHY

Course Code : **OCN 4109**
Credits : 3.0

Objective:

To analyze and evaluate scientific data to create a conclusion about oceanographic processes.

Syllabus Contents:

1. Introduction, Natural History of the Course
2. CTD Cast
3. Bathymetry, Bathymetry Mapping
4. Halifax Harbor Background & Physical Measurements
5. CTD Data Plotting
6. Optical Measurements & Water Sampling
7. Nutrients; Optics
8. Phytoplankton & Nutrients
9. Secchi Disk & PAR Meter Data Analysis
10. Phytoplankton & Pigment Samples (Niskin Bottles)
11. Plankton Net Tows, Deploy Sediment Traps, Plankton Microscopy
12. Respiration, Grazing
13. BOD, Pigment Analysis, Deploy BOD Bottles

14. Benthic Grabs, Sediment Coring, Sediment Sample Processing
15. Recover BOD Bottles, Recover Sediment Traps, Sediment Coring
16. Oxygen Measurements, Sediment Sample Processing, Biogeochemistry & Sediment Cores
17. Fish & Fisheries, Marine Mammals, Fishing, Swimming.

Recommended Text(s):

1. Paul, R.A.,1996, ***Exercises in Meteorology,*** Prentice-Hall, Englewood Cliffs, NJ; ISBN: 0-02-393212-0
2. Thurman, H. &Savin, S.M.,1996, ***Laboratory Exercises in Oceanography***, McGraw-Hill, Boston, MA; ISBN:0-02-420806-x

DATA COLLECTION & ANALYSIS IN OCEANOGRAPHY (LAB)

Course Code : **OCN 4110**
Credits : 1.5

Objective:

To provide practical experience using the data analysis tool for oceanographic applications.

Syllabus Contents:

1. CTD Cast, CTD Data Plotting
2. Bathymetry Mapping
3. Optical Measurements & Water Sampling
4. Secchi Disk & PAR Meter Data Analysis
5. Phytoplankton & Pigment Samples (Niskin Bottles), Plankton Net Tows, Deploy Sediment Traps, Plankton Microscopy
6. BOD, Pigment Analysis, Deploy BOD Bottles
7. Benthic Grabs, Sediment Coring, Sediment Sample Processing
8. Recover BOD Bottles, Recover Sediment Traps,Sediment Coring
9. Fish & Fisheries data collection.
10. Satellite data collection and Analysis
11. Data analysis and visualization tools: Ferret, Matlab etc

Recommended Text(s):

1. Thurman, H. &Savin, S.M.,1996, ***Laboratory Exercises in Oceanography***, McGraw-Hill, Boston, MA; ISBN:0-02-420806-x

COURSE CURRICULUM

INTEGRATED COASTAL ZONE MANAGEMENT

Course Code : **OCN 4201**
Credits : 3.0

Objective:

To impart knowledge on the management of the coast using an integrated approach, regarding all aspects of the coastal zone, including geographical and political boundaries to achieve sustainability.

Syllabus Contents:

1. Introduction and Concepts,
1.1 Definitions of ICZM
1.2 Boundaries of the coastal zone
1.3 View of coastal zone as a system
1.4 Characteristics of the coastal zone
1.5 Needs and objectives of ICZM (Component uses, Ecosystem uses, Functions)
2. Multiple Uses of the Coastal Zone
2.1 Urban settlement
2.2 Industrial development
2.3 Tourism and recreation
2.4 Waste disposal
2.5 Shore protection works
2.6 Port and marine transportation
2.7 Land transport infrastructure
2.8 Capture fisheries
2.9 Aquaculture
2.10 Sea salt production
2.11 Coastal agriculture
2.12 Extraction industries
3. Coastal Zone Management Issues
3.1 Population growth
3.2 Resource exploitation
3.3 Land use change
3.4 Conservation reserves and protection of biodiversity
3.5 Resource use conflicts
3.6 Horizontal and vertical integration
4. Tools and Techniques for ICZM
4.1 Administrative (Policy and legislation, Guidelines, Zoning)
4.2 Social (Traditional practices, Collaborative and community-based management, Capacity building)
4.3 Technical (Environmental Impact Assessment, Risk and hazard assessment and management, Landscape and visual resource analysis, Economic analysis, Remote Sensing and GIS)
5. ICZM Planning Cycle
5.1 Classifying coastal management plans
5.2 Designing a coastal planning framework
5.3 ICZM plans described by geographical coverage (International integrated plans, Regional scale integrated plans, Local area integrated plans, Site-level integrated plans)

5.4 Planning processes (Administrative process, Public participation, Producing the plan)
5.5 The implementation of coastal management plans
5.6 Monitoring and evaluation
5.7 Case study

Recommended Text(s):

1. Coastal planning and management, by R. Kay and J. Alder, 1999
2. Coastal environmental management plan for Bangladesh, ESCAP, 1988
3. Integrated management of coastal zone, by John R. Clark. FAO, 1992
4. Integrated coastal management: South Asia, by B. E. Brown. DFID, 1997
5. Planning and management for sustainable coastal aquaculture development, GESAMP, 1999

COASTAL MORPHOLOGY AND PROCESSES

Course Code : **OCN 4203**
Credits : 3.0

Objective:

To enable students to analyse coastal areas morphologies and processes, both natural and anthropogenic ones as well to interact with the different professionals working.

Syllabus 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 responses
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, long shore currents and transport along the coast
10. Sediment cycles and movements in coastal waters.

Recommended Text(s):

1. Coastal Hydraulics, A.M. Mouir.
2. The earth and its ocean, A.C. Duxbury.

MARINE BIODIVERSITY AND CONSERVATION

Course Code : **OCN 4205**
Credits : 3.0

COURSE CURRICULUM

Objective:

To develop an understanding of the major issues in marine biodiversity research and the relationship between the terms structural and functional biodiversity.

Syllabus 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 Text(s):

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.

GLOBAL CLIMATE CHANGE

Course Code : **OCN 4207**
Credits : 3.0

Objective:

To learn how the climate system works, what factors cause climate to change across different time scales and how these factors interact.

Syllabus 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.

Recommended Text(s):

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

THESIS

Course Code : **OCN 4209**
Credits : 6.0

COURSE CURRICULUM

Objective:

To demonstrate skill in research, writing and analysis.

Learning Outcomes:

The students will gain hands-on research experience through completing a research project, starting with hypothesis development, literature searching, experimental design, data collection, analysis, and interpretation. Students will also gain experience in written and oral communication by submitting several written components including research proposal, progress report, and final thesis as well as presenting the results of their research in a oral presentation.

General Guides:

1. Thesis students can be attached in any Maritime related enterprises, government and semi-autonomous institutions, NGOs, development projects, or research institutions for a required period (if necessary) as decided by BSMRMU Authority.
2. Thesis students shall follow relevant instructions of BSMRMU Examination Regulation.