Bangabandhu Sheikh Mujibur Rahman Maritime University, Bangladesh (BSMRMU)

Course Curriculum
of
Master of Science (MSc) in Oceanography

Department of Oceanography and Hydrography
Faculty of Earth and Ocean Science

First Publication: Effective from the Academic Session: 2021–2022

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AUTHOROTY OF PUBLICATION

1. A committee, formed vide memorandum no. BSMRMU/Reg:/Council/Syndicat-377/20/1987 dated 29 November 2020 drafted the curriculum of Master of Science (MSc) in Oceanography. The committee comprises with the following members:

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Record of Amendments

Change No	Date Inserted	Signature	Name	Remarks

Course Curriculum of
Master of Science (MSc) in Oceanography Programme

1. Introduction to the University

1.1. Background

1.1.1 The victory over maritime boundary delimitation with neighboring countries opened a new window in the maritime arena of Bangladesh. Vast sea area along with scarcity in land-based resources has made it imperative to boost up our economy through effective exploration of sea resources. Keeping this in perspectives honourable Prime Minister Sheikh Hasina outlined the concept of blue economy and underscored the importance of effective manpower in the maritime sector.

1.1.2 In order to create effective human resources, the first ever specialized university Bangabandhu Sheikh Mujibur Rahman Maritime University, Bangladesh (BSMRMU) was established in 2013 after the name of the Father of the nation Sheikh Mujibur Rahman. Our motto is "We strive for Maritime Excellence". The University aims at bringing all maritime professional to a common platform to share knowledge and carryout research for the advancement of maritime sector and developing effective human resources in this sector.

1.2 Vision

Vision of the University is to promote and create a learning environment for higher maritime education with excellence, through state-of-the-art facilities and gadgets, competent faculty and staff, expanded frontier of research based knowledge and international standards supportive of the new horizons in diverse fields.

1.3 Mission

BSMRMU is committed to provide quality education based on state of the art technological support responsive to the emerging challenges at home and abroad. The university is dedicated to nurture and develop world class professionals, who would serve the mankind with strong sense of ethical values and competence and ready to face the competitive world of maritime business, service and employment.

1.4 Goals

Goals of the University are as follows:

- ❖ Achieve sustainable development and progress of the university through mutual cooperation with other related universities/ institutions.
- ❖ Continue to upgrade educational services and facilities responsive to the demands and requirements of the nation.
- ❖ Bring all types of marine professionals on a common platform to share knowledge and perform research and development works for the advancement of country's maritime sector.

- ❖ Enhance research consciousness in the maritime sector in discovering new dimensions with the upcoming challenges.
- ❖ Accelerate the participation of alumni students and professionals with educational programs and development of projects designed to expand and improve academic standards.
- ❖ Teach students on marine science and technology and guide them towards research to enhance contribution to the maritime profession.
- ❖ Conduct various educational programmes and research works for sustainable development of the maritime service and industrial sector of the country.
- ❖ Educate students on different subjects of maritime management, law and security and strategy and conduct research on allied fields.
- ❖ Create conducive environment for students to prepare themselves to serve the nation as future planners/ policy makers/ leaders in maritime sectors in coordination with national and international organizations including International Maritime Organization (IMO).

1.5 **Faculties and Institutes.** The University aspires to have seven teaching faculties and four research institutes. The faculties are:

a. Faculty of Maritime Governance & Policy (FMGP),
b. Faculty of Shipping Administration (FSA),
c. Faculty of Earth and Ocean Science (FEOS),
d. Faculty of Engineering and Technology (FET),
e. Faculty of Computer Science and Informatics (FCSI),
f. Faculty of Maritime Business Studies (FMBS),
g. Faculty of General Studies (FGS).

1.6 **Research institutes**. Research institutes are: Institute of Professional Language, Institute of Bay of Bengal & Bangladesh Studies, Institute of Renewable Energy & Marine Resource and Institute of Disaster management.

2. Introduction to the Faculty of Earth and Ocean Science

2.1 The ocean is the last and least unexplored frontiers of the planet Earth. For this reason Department of Oceanography and Hydrography of BSMRMU is committed to produce skilled manpower on ocean science, ocean resources and ocean environment as well as to understand all facets of the its complex connections with Earth's atmosphere, land, geology, ice, seafloor, and life- including humanity. Faculty of Earth and Ocean Science is one of the oldest faculties of the university. The faculty has special learning environment, innovative course curriculum, methods of teaching, and quality programmes. Faculty of Earth and Ocean Science is comprised of the following departments:

a. Oceanography and Hydrography
b. Mining
c. Marine Fisheries and Aquaculture
d. Marine Biology
e. Genetic Engineering and Biotechnology
f. Environment Studies

3. Introduction to the Department of Oceanography and Hydrography

3.1 In recent years, Bangladesh Government has taken the ocean as a new economic frontier and developed growth policies based on the concept of blue economy. It is aimed to enhance livelihoods for the poor, create employment opportunities and reduce poverty. The Department of Oceanography and Hydrography started its journey from the very inception of this University under the Faculty of Earth and Ocean Science. The Department is committed to provide an excellent teaching and learning environment and research opportunities for graduate and undergraduate students in Bangladesh with degrees in Oceanography which will contribute in producing skilled and trained scholars and manpower in the field of blue economy. Global standard curriculums are followed to impart quality education by the qualified and competent teachers. Graduates and Masters of this department will get a unique opportunity to develop their career in the different areas of job market especially in the field of oceanography and Hydrography in home and abroad.

4. Introduction to the Programme

4.1 **Background.** Under the Department of Oceanography and Hydrography an Undergraduate Programme "B.Sc. (Honours) in Oceanography" is running and its first batch will complete honours degree by December 2020. In order to open, the scope of higher study on oceanography a Master of Science (MSc) in Oceanography Programme is going to start its activities from 2021. Emphasis will be given to the physical, chemical, biological, geological and atmospheric aspects of the Indian Ocean especially the Bay of Bengal. The Master of Science in Oceanography degree program fosters a broad understanding of oceanic systems through an interdisciplinary program of study. On completion of the programme the students will be able to build their careers across the public and private sector at home and abroad.

4.2 **General.** Master of Science (MSc) in Oceanography is a 18 months full time regular postgraduate programme under the Department of Oceanography and Hydrography. The programme is divided into 3 semesters of 6 months each. The programme is designed with 11theoretical courses and a Thesis/ project. Besides, the student has to perform a fieldtrip/study tour, lab work and seminar. Total credit for the programme is 51. The main purpose of Master of Science (MSc) in Oceanography programme is to train the students in relevant areas of Oceanography to be professional.

4.3 **Division of Semester.** The duration of each semester is 26 weeks. In each semester, 15 weeks is dedicated for classroom learning, while remaining weeks are utilized for makeup classes, preparatory leave, final examination and other curricular and co-curricular activities. Distribution is as follows:

a.	Classes	15 weeks
b.	Mid Term Examinations	02 weeks
c.	Preparatory Leave	02 weeks
d.	Term Final Examination	03 weeks
e.	Recess	04 weeks

5. Vision of the Programme

5.1 Developing world-class postgraduate to penetrate the Oceanography and Hydrography professionals.

6. Mission of the Programme

6.1 Supporting and structuring industry attractive curriculum and state of the art teaching.

7. Programme Outcomes

7.1 Programme outcomes are as follows:

a. Demonstrate an interdisciplinary knowledge of coastal and marine systems.

b. Demonstrate the understanding of fundamentals of oceanography; including Physical, Biological, Chemical, Geological Oceanography and Hydrographic activities.

c. Demonstrate an advanced ability to apply and integrate scientific principles and research data to address complex questions in marine systems.

d. Demonstrate the ability to plan and implement observational, theoretical, and experimental studies.

e. An ability to formulate oceanographic problems and develop practical solutions in this field.

f. To promote cross-disciplinary, multiscale research and education in oceanography and hydrography.

g. Have the competence to gain employment in advanced resource management positions or entrance to a doctoral program in related fields.

h. Demonstrate competence in scientific communication through producing technical and scientific articles and participating in oral presentations.

8. Students Learning Outcomes

8.1 After the successful completion of the Master of Science (MSc) in Oceanography programme, the students will be able to

a. Describe the three-dimensional distributions of temperature, salinity and momentum in the ocean and atmosphere, and explain the oceanic and atmospheric processes that control these distributions.

b. Describe the progressions of major earth science theories, including new analytic methods, sensors, and numerical methods in the field of oceanography.

c. Identify, construct, and analyze coupled dynamical systems by which geological, atmospheric, oceanographic, chemical, and biological processes interact throughout a range of spatial and temporal scales.

d. Collect and manipulate oceanic, atmospheric, and geospatial data sets and rigorously analyze and interpret observational data, in situ experimental data, and model results.

e. Explain how living organisms capture and process energy; photosynthesis, metabolism, primary productivity in the ocean and ocean chemistry and processes of nutrient cycling.

f. Classify oceanic life, marine environment and systems of nomenclature and describe various marine communities; their types and composition.

g. Discuss the physical factors affecting marine life, succession and other changes in marine communities.

h. Evaluate the interaction between humans and the ocean.

i. Explain how physical and chemical factors in the ocean affect the climate in the past, present and future.

j. Interpret and critique professional scientific literature.

9. Generic Skills

9.1 The generic skills for the programme is advanced oceanographic knowledge, oceanic and atmospheric processes, information technology, ocean dynamical systems, ocean health and global climate change, computer programming for oceanographic research, satellite oceanography and ocean mapping and GIS.

10 Admission Criteria

10.1 Applicants must fulfil the admission requirements as prescribed by Bangabandhu Sheikh Mujibur Rahman Maritime University, Bangladesh (BSMRMU).

10.2 **Admission Requirements.** The minimum requirements for admission in Master of Science (MSc) in Oceanography program under the Department of Oceanography and Hydrography are as follows:

a. Applicants must have a Bachelor Degree in Oceanography, Geography and Environment, Geology, Zoology, Fisheries, Marine Science, Environmental Science, Physics, Botany, Chemistry or equivalent degree. Masters candidates in related subjects can also apply.

b. Applicants must have 2nd class or CGPA 3.5 in SSC & HSC and CGPA 3.0 in Bachelor Level. 3 years Bachelor holders must have 1 year Masters with CGPA minimum 3.00.

c. Applicants having B.Sc. (Honours) in Oceanography from BSMRMU will get priority.

d. Foreign applicants shall apply through their respective embassy

11. Admission Test

11.1 **Admission Period.** The admission notice shall be circulated usually in the month of February/ March for admission of April Batch and July/August for admission of October Batch of each year through media advertisement, BSMRMU website, and notice board.

11.2 **Admission Test Syllabus and Marks Distribution.**

11.2.1 All eligible applicants shall be required to appear the admission test as per BSMRMU Admission Policy/ regulations for Master's degree. Admission test shall normally be comprised of written test and viva-voce. Only written test qualified applicant shall be called for viva voce. The exam pattern will be of MCQ and short descriptive answers. An eligible candidate has to sit for a written admission test of 100 marks, and the time for the test will be 90 minutes. Subjects of the admission test and mark distributions shall be specified by the Department of Oceanography and Hydrography.

11.2.2 The admission criteria, the minimum requirements for admission in MSc in Oceanography degrees, subjects of the admission test and mark distributions are will be defined and recommended by the Academic Committee of the Department of Oceanography and Hydrography and duly approved from the Academic Council.

11.2.3 **Final Selection.** Candidates will be selected finally based on their combined marks obtained in the written admission test (100), viva voce (30), Bachelor Degree/ equivalent examination (40), HSC/equivalent examination (20) and SSC/equivalent examination (10). Final merit list along with waiting list will be published on BSMRMU notice board as well as on BSMRMU website.

Example: An example of calculating the final total score is given below:

Evaluation Source	**Total Marks/ GPA/ CGPA**	**Marks/ GPA/ CGPA Obtained**	**Total Score (200)**
Written Test	100	52	52.00
Viva	30	20	20.00
Bachelor/ equivalent	4.0	3.2	3.2 x 10 = 32.00
HSC/ Equivalent	5.0	4.0	4.0 x 4 = 16.00
SSC/ Equivalent	5.0	4.5	4.5 x 2 = 9.0
Total Score			**129.00**

11.2.4 **Registration/Admission in the Programme.** After final selection, selected candidates shall be registered with the programme following the procedures as laid down by BSMRMU. The candidates have 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 the required fees.

11.2.5 **Cancellation of admission.**

a. If any candidate fails to complete admission formalities within the prescribed date and time, his/her selection will be cancelled automatically.

b. If any student does not attend the class within two weeks of commencement of classes, his/her admission will be cancelled automatically.

12. **The medium of Instruction and Examination**

12.1 The medium of instruction and answer in the examination scripts shall be English.

13. Eligibility to Appear at the Semester Final Examinations

13.1 To be eligible for appearing at the examination, a candidate shall have to fulfil the following criteria:

a. A student has to participate in the required number of classes, practical classes, tutorials and fieldworks (if required). In this case, a student has to participate in the following number of classes to sit for the examination:

(1) 75% or above- Qualified.

(2) 60%- 74%- Non-Collegiate. In this case, the student has to apply for appearing in the examination and pay the required fees.

(3) 59% or below- Disqualified.

b. Candidates shall have to fulfil the other conditions mentioned in the examination circular.

14. Performance Evaluations

14.1. Continuous Assessment.

14.1.1 The basis for continuous assessment awarding marks for class attendance will be as follows:

Class Attendance Rate	Allocated Marks
90% and above	100%
85% to 89%	90%
80% to 84%	80%
75% to 79%	70%
70% to 74%	60%
65% to 69%	50%
60% to 64%	40%
59% and below	0%

14.2 Theory Courses.

14.2.1 Forty percent (40%) of marks of theoretical course shall be allotted for continuous assessment, i.e. quizzes, class tests, home assignments, class evaluation, class participation, mid-exam etc. Semester Final Examination is conducted centrally by BSMRMU. Semester Final Examination will be normally of 3-hour duration. Distribution of marks for a given course is as follows:

a.	Class Attendance	05%
b.	Class Participation/Observation	05%
c.	Semester Paper/Assignment	05%
d.	Class Tests/Quiz	10%
e.	Mid-term Examination (01 Exam)	15%
	Total Marks for Continuous Assessment =	40%
f.	Semester Final Examination	60%

14.2.2 The number of quizzes/class tests of a theory course shall be *n+1,* where *n* is the number of credit hours of the course. Evaluation of performance in quizzes/class tests will be based on the best *n* quizzes/ class tests.

14.2.3 A number of individual and group assignments, presentations, etc. shall be assigned to students as per the course requirements. The number of assignments of a theory or practical is *m,* where *m* is the number of credit hours of the course.

14.3 **Lab Courses.**

14.3.1 The distribution of marks for Lab courses is given below:

a.	Lab test	40%
b.	Assignment / Report	20%
c.	Viva/ Presentation	10%
d.	Quiz	10%
e.	Attendance	10%
f.	Class Performance / Observation	10%
	Total =	100%

14. 4 **Field Trip.**

14.4.1 The distribution of marks for the field trip is given below:

a.	Attendance	20%
b.	Participation	20%
c.	Visit Report	30%
d.	Presentation	30%
	Total =	100%

14.5 **Viva-Voce.**

14.5.1 A regular student must appear at the viva-voce as per course curriculum. At the end of the semester final examination, the Examination Committee of the Department shall hold the viva-voce where the students will be examined for the whole semester.

14.5.2 If a student fails to appear at the viva-voce, the Examination Committee of the Department may recommend him/ her for appearing at the viva-voce within the 30 days from the (date of preceding regular). However, the candidates shall have to take permission from the Vice-Chancellor producing necessary documents. In this case, she/he shall have to bear all expenses to conduct the viva-voce as fixed by the University Authorities.

14.5.3 If a student does not avail the above clause i.e. does not appear at the annual viva voce, she/he shall be declared to have failed in the respective examination.

15. **Grading System**

15.1 The total numerical marks obtained by a student in each theoretical and practical course will be converted into letter grades. Letter grades and corresponding grade points will be awarded following the provisions as per the University Grants Commission (UGC) grading system, as shown below:

Numerical Score	Letter Grading System	Letter Grade	Grade Points
80% and above	A+	A Plus	4.0
75% to 79%	A	A Regular	3.75
70% to 74%	A-	A Minus	3.5
65% to 69%	B+	B Plus	3.25
60% to 64%	B	B Regular	3.0
55% to 59%	B-	B Minus	2.75
50% to 54%	C+	C Plus	2.5
45% to 49%	C	C Regular	2.25
40% to 44%	D		2.0
Less than 40%	F		00

16. **The Requirements for Promotion to the Next Term**

16.1 A student is required to fulfil the following conditions for promotion to the next higher class/ semester:

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

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

17. **Failed Student**

17. Following guidelines will be followed for a failed student:

a. If a student gets 'F' grade in three or more subjects in a level (year/ session) of two semesters, he/ she will be required to repeat all the courses of that session. He/she must earn the credits required for the post-graduate program within three years;

b. If a student gets 'F' grade in not more than two subjects/ courses in one regular semester, then in order to improve the result, he/ she will be allowed to participate in improvement exam of 'F' graded subject/ subjects with the next semester (as *Retake* subjects/ courses);

c. If a student fails to improve from 'F' grade in the first attempt then this subject/ course will be considered as *backlog* subject/ course and he will get the opportunity to improve from 'F' grade by participating in the next final examination for the second and last chance.

d. A student participating in the improvement examination may be awarded a maximum letter grade B (grade point 3.00);

e. If a student fails in the improvement examination, he/ she will pass to the next session if fulfils the above criteria. However, he must participate in the subsequent improvement examination of the subject and pass in that subject as a *backlog* subject. Otherwise, he/she will be withdrawn from the program;

f. If, due to illness (supported by a medical certificate), a student is unable to attend more than 60% of the classroom lessons or the final examination in the semester, he/she

can be withdrawn from the current semester and repeat all the courses of the next session after the approval of the Academic Council.

18. Credit Earned

18.1 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 the designated period.

19. Degree Requirements

19.1 For the MSc in Oceanography degree, a student shall require to fulfil the following conditions:

a. A student must complete all the courses within a maximum of three years.

b. According to the syllabus of the program, the student has to pass the final examination of each course.

c. A student must submit his/ her research paper/ project and present it before the designated panel after fulfilling the required conditions.

d. A student must achieve a minimum of 2.2 CGPA in the programme.

20. The degree to be Awarded

20.1 A student who has secured a minimum CGPA of 2.2 after all the semesters will be awarded Master of Science (MSc) in Oceanography.

21. Year of Degree Awarded

21.1 The results of a candidate for Masters Degree shall be awarded in the year in which she/he fulfils the requirements for the degree.

22. Improvement of Grades

22.1 If a student passes a course with a grade point between 2.0 and 2.75, he/she will have the opportunity to participate in the improvement exam in that course only once. In this case, a student will be allowed to participate in the improvement exam only one subject/ course in a semester.

22.2 If a student fails to improve his/ her previous grade despite participating in the improvement exam, his/ her previous grade will remain valid.

22.3 For improvement of grade, the improvement exam will mean only the theoretical part (60%) of the subject/ course. In the case of Laboratory/ Practical/ Sessional/ Oral Examination, the improvement exam will not be accepted.

22.4 The fee for improvement examination shall be fixed by the University.

23. Re-admission

23.1 If a student fails to appear at any semester final examination due to shortage of required percentage of class attendance or any other reason, s/he shall have to get himself/ herself re-admitted as an irregular student with the batch that immediately follows on the recommendation of and within the date fixed by the Academic Committee of the Department. She/ he must have to fulfil the requisite class attendance for appearing at the examination as an irregular candidate. The student shall be allowed to appear at the respective examination only once with the batch that immediately follows as an irregular candidate, failing which she/ he shall be dropped out of the programme. If are admitted student earns required GPA for promotion as an irregular candidate in 1st to final semester examination, but failed in any course/s, she/ he shall not be allowed to appear in the failed course/s to improve GPA under any consideration.

23.2 Re-admission will not be allowed in the 1st semester, if percentage of class attendance of the student is below 30, then his/ her studentship will be treated as cancelled, i.e. she/ he will be dropped out of the programme.

23.3 A student may be allowed re-admission for not more than once in a particular semester and not more than twice in the entire programme.

24. Collection of Tuition Fees

24. The Controller of Accounts will make arrangement to collect tuition and session fees of the respective session from a student who will be promoted to next semester, within two months after publication of the result of semester final examination. If s/he fails to deposit fees within the time, s/he may be given another 30 days to deposit the same with late fine fixed by the University Authority, failing which his/her name shall be struck off the University Register. i.e. s/he shall be dropped out of the programme.

25. Admission of the Expelled Student

25.1 If a student adopts unfair means in any examination, and s/he if is penalized with the cancellation of the result of his/ her respective semester, then his/her results of the previous semester/s, if any, shall remain valid.

25.2 If a student of any semester is expelled from the University for any reason as the case may be, she/ he shall have to get himself/ herself re-admitted to the subsequent semester respectively for once only. Generally, the syllabus in force for the examination concerned will be applicable for such a student. If any drastic changes in the syllabus are made, she/ he shall have to appear at the examination with his/ her original syllabus on the recommendation of the Academic Committee of the Department.

25.3 The expelled period shall not be counted for calculating the maximum available period (3 years).

26. Course Waiver

26.1 A student with relevant degrees from reputed universities may get maximum 16 credits waiver provided they fulfil the following conditions:

a. Obtained at least a 'B' grade or 1st class in a similar course in the earlier programme.

b. Minimum least 70% of the course contents are similar.

All applications for course waiver will be reviewed by Equivalence Committee on a case-by-case basis and finally shall be approved by the Academic Council of BSMRMU.

27. Tracks of the Thesis and Project Programme

27.1 For a large number of MSc in Oceanography in a class, it will not be feasible to assign, supervise and manage thesis for all the students. Moreover, considering future employment opportunities students may be split into different activities like Thesis/ Project/ Group Project/ Attachment/ Internship etc. Thus, the students of the MSc in Oceanography will be divided into two tracks in the final semester, which are as follows:

a. **Thesis Group.** Students having CGPA 3.5 or higher (up to the Masters 2nd semester result) can enroll in the Thesis group. However, a student qualified for the thesis will have the liberty to select the general group. The thesis group is a research-based programme that emphasizes a hands-on approach to learning through the completion of an original thesis project under the direct mentorship/ supervision of an experienced researcher. The purpose of the thesis group is to give students the opportunity to develop a strong foundation in research methodology. Individualized programs of study ensure that each student has the best possible preparation based on their interests, background, and abilities. Thesis students take core and elective courses while engaging in an intensive, independent research project. Students work side-by-side with a faculty mentor to discover or synthesize knowledge that contributes to the formation of new theories/ knowledge.

b. **Project Group.** Students having less than CGPA 3.5 (up to the Masters 2nd semester result) have to enroll in the Project Group. The Project Group students will get an opportunity for an individual project. The project group will primarily be designed for students seeking careers in private/ government sectors, and who do not prefer or are not capable enough to build up their career as a faculty member or researcher. In special cases, the project Group students may also be given the opportunity for group project/ internship/ industrial attachments etc.

27.2 Selection of Thesis Title and Supervisor.

27.2.1 Course Coordinator will inform the students about their eligibility for thesis group or project group based on result up to the Masters 2nd semester. Academic Committee of the Department of Oceanography and Hydrography will allocate supervisor for all the students where the choice of students will get priority. With the guidance of supervisor, students will select their topic of the thesis/ project and the same will be consolidated and verified by the Academic Committee of the Department of Oceanography and Hydrography.

27.2.2 HoD will forward the list of students, recommended name of supervisors and thesis title/ project title to the Board of Post-graduate Studies and Research (BPGSR) for approval. The BPGSR will scrutinize and finalize the list of supervisors and thesis title/ project title. The BPGSR will approve the project title, project cost and name of the Supervisor and will forward the same to the Controller of Examination informing Vice-Chancellor's. Controller of Examination will issues a letter to the concerned department notifying course coordinator.

27.2.3 If any matter of the approved project (title, project cost and supervisor) needs to be changed, it has to be approved by the BPGSR on the recommendation of Dean of the concerned faculty.

27.2.4 **Submission of the Thesis/ Project.** Students will submit the Thesis/ Project to the course coordinator/ HoD within the prescribed time period with a certificate of plagiarism checked from supervisor. HoD will forward the papers to both external and internal examiner of the Thesis/ Project evaluation. One copy of the thesis shall be sent by the Chairman of the Thesis/ Project Examination Committee and another copy to the University Library for future reference.

27.3 **Examiners for Evaluation Thesis/ Project.** With the recommendation of HoD, the Controller of Examination will select two examiners (one external and one internal) for evaluation of each student's research/ project report. Both the examiners will evaluate the thesis/ project report separately for 60 marks. The arithmetic mean of the marks awarded by the internal and external examiners will be counted for the evaluation of papers. In case the marks awarded by the two examiners differ by 20% or more, the Controller of Examination shall recommend that the paper be re-examined by the third examiner and the arithmetic mean of the two nearest marks will be counted.

27.4 **Marks Distribution of the Thesis/ Project**. Marks distribution of the thesis/ project is as follows:

Content	**Marks**	**Remarks**
Thesis/ Project Report	60%	Examiners of Thesis/ Project Report Evaluation
Presentation	30%	Thesis/ Project Examination Committee
Oral Examination	10%	Thesis/ Project Examination Committee
Total Marks	**100%**	

27.5 **Selection Criteria of the Thesis/ Project Supervisor.** The research/ project work of the students of the MSc in Oceanography program will be conducted under supervision of a supervisor. Academic Ordinance for Post-graduate Programme will be followed for selection of thesis/ project title, supervisor, co-supervisor and for other matters related to thesis and project.

28. Curriculum Structure

28.1 Master of Science (MSc) in Oceanography programme consists of the following categories of courses:

Category of the Course	**Project Group**			**Thesis Group**		
	No. of Courses	**Credit**	**%**	**No. of Courses**	**Credit**	**%**
Fundamental Courses (FC)	2	6	11.76%	2	6	11.76%
Core Courses (CC)	6	18	35.29%	6	18	35.29%
Allied Courses (AC)	3	8	15.69%	3	8	15.69%
Elective Courses (EC)	1	3	5.88%	-	-	0.00%
Skill Development Courses (SKD)	3	7	13.73%	3	7	13.73%
Project/ Thesis / Dissertation	1	9	17.65%	1	12	23.53%
Total	15	51	100 %	14	51	100%

29. **Course Schedule**

29.1 The course schedule of the program is as follows:

Semester – 1				
Sr.	Sub Code	Course Title	Credit	Category
1	OCN M101	Advanced Satellite Oceanography	3	CC
2	OCN M103	Marine Affairs and Geopolitics of World Ocean	3	AC
3	OCN M105	Advanced Physical Oceanography	3	CC
4	OCN M107	Marine Geology and Geophysics	3	CC
5	OCN M109	Ocean Governance and Marine Spatial Planning (MScP)	3	AC
6	OCN M111	Climate and Atmospheric Science	3	SKD
		Sub Total	**18**	
Semester – 2				
7	OCN M201	Ocean Mapping	3	FC
8	OCN M203	Numerical Methods and Ocean Modelling	3	FC
9	OCN M205	Advanced Marine Biotechnology and Therapeutics	3	CC
10	OCN M207	Ocean and Coastal Hydrodynamics	3	CC
11	OCN M209	Sea Farming Technology	3	CC
12	OCN M202	Viva-voce	2	AC
		Sub Total	**17**	
Semester – 3				
	Project Group			
13	OCN M301	Seminar in Oceanography	2	SKD
14	OCN M302	Field Work	2	SKD
15	OCN M303	Lab Work	3	EC
16	OCN M304	Project Report (Project Report-7; Project Presentation & Viva-2)	9	
		Sub total	**16**	
	Thesis Group			
17	OCN M301	Seminar in Oceanography	2	SKD
18	OCN M302	Field Work	2	SKD
19	OCN M305	Thesis (Thesis-10; Thesis Presentation & Viva-2)	12	
		Sub total	**16**	
		Total	**51**	

Note: 1. Total Credit of the programme (18+17+16) = 51 credits

2. Thesis/ Project proposals are to be submitted at the beginning of the 2nd semester.

3. Code Words:

- Fundamental Courses (FC)
- Core Courses (CC)
- Allied Courses (AC)
- Elective Courses (EC)
- Skill Development Courses (SKD)

Detail Syllabus
Semester - 1

Course Code: OCN M101	**Credit:** 3
Course Title: Advanced Satellite Oceanography	

Rationale: This course is designed for the students to learn about different aspects of Advance level satellite Oceanography specially the remote sensing system in depth.

Course Objectives: The objectives of the course are to:

- ✓ Understand the Remote sensing system in depth.
- ✓ Analyze and evaluate different ocean parameters by using satellite data.
- ✓ Understand different constrains of satellite oceanography and how to overcome them.

Learning Outcomes: Having successfully completed this course, students will be able to:

- Explain different aspects of remote sensing.
- Learn to measure different ocean parameters by using satellite data.
- Understand different constrains of satellite oceanography and how to overcome them to get best quality data.

Syllabus Contents:

1. Remote sensing system, Satellite systems compared with ground based observing system. Satellite orbits: Newton's laws, Kepler's laws, Kepler's equation, orientation in space, orbital elements, Geostationary orbits, Sun synchronous orbits, other orbits, revisit intervals.
2. Radiative Transfer: Electromagnetic radiation, black body radiation laws, non-black bodies radiative transfer equation, Schwarzschild equation, gaseous absorption and scattering.
3. Satellite imagery: Creating images, spatial resolution, visible imagery, infrared imagery, water vapor imagery, microwave imagery. Image enhancement techniques, weather systems observed in satellite imagery, Monsoons, Tropical Cyclones.
4. Clouds: clouds from images; Precipitation: Visible and Infrared technique, Passive microwave technique, GOES precipitation index. Estimation of earth radiation
5. Ocean properties measurable from satellites. Ocean Color Remote Sensing: optical theory for Ocean color remote sensing, recovering useful information from ocean color, estimating water parameters from spectral band ratios, identifying Potential Fishing Zones.
6. Physical principles of IR radiometers; IR measurement of Sea Surface Temperature – retrieving SST: IR Radiometer, AVHRR, Oceanographic application of IR SST data. Passive microwave Radiometers: Physical principle of passive microwave radiometry, retrieval of Salinity, SST and surface wind from microwave measurements.
7. Radar Altimeters over the Ocean: Principles of satellite altimetry, measuring distance with a radar altimeter, Ocean currents from altimetry, estimating wave height and wind speed.

Suggested Reference Text Books:

- ✓ Measuring the oceans from space- Ian S. Robinson
- ✓ The principles and methods of satellite oceanography- Ian S. Robinson
- ✓ Discovering the ocean from space- Ian S. Robinson

- ✓ The unique applications of satellite oceanography – Ians Robinson
- ✓ Satellite meteorology an Introduction – stanley Q. Kidder, Thomas H. Vander Harr
- ✓ Satellite Meteorology- R. R. Kelkar
- ✓ Applications with Meteorological satellites – W. Paul Menzel
- ✓ Fundamentals of Remote sensing – George Joseph, 2003
- ✓ Oceanographic applications of Remote Sensing – Motoyoshi Ikeda, Frederic W. Dobson
- ✓ Satellite Meteorology an Introduction by Stanley Q. Kidder and Thomsas H. VonderHaar, 1995.
- ✓ 11. Lecture Notes for Post Graduate Course on Satellite Meteorology and Global Climate,Vols.1,2 and 3. ISRO Publications, 1998, 2002

Course Code: OCN M103	**Credit:**3

Course Title: Marine Affairs and Geopolitics of World Ocean

Rationale: This course has been designed for students to learn about different maritime laws and regulations, regulatory bodies and authorities and the geopolitics of the countries for maritime interest especially for economic benefit, power projection and spread influence regional and worldwide.

Course Objectives: The objectives of the course are to:

- ✓ Learn different maritime laws and their applications.
- ✓ Learn ocean governance and management of ocean and how it can support blue economy program for sustainable development.
- ✓ Understand the geopolitics of World Ocean and the strength and weakness of Bangladesh as a maritime state.

Learning Outcomes: Having successfully completed this course, students will be able to:

- ✓ Describe different maritime laws and their applications.
- ✓ Understand ocean governance and management of ocean to support blue economy.
- ✓ Understand the geopolitics of World Ocean and the strength and weakness of Bangladesh as a maritime state.

Syllabus Contents:

1. International maritime laws on rights and responsibilities, fishing, marine pollution, conservation, safety of life at sea, and collision prevention at sea.

   1.1 United Nations and other international bodies involved in regulating maritime affairs: UNGA, IMO, FAO, WMO, IHO etc.
   1.2 UNCLOS: history, salient features, Area Beyond National Jurisdiction (BBNJ, ABNJ), Marine conservation under the Law of the Sea convention; status of marine conservation in Bangladesh, Maritime boundary delimitation case study.
   1.3 Marine pollution and its adverse effect. International treaties relating to marine pollution and its prevention: INTERVENTION 1969, London Convention/LC 1972, MARPOL 1973, 1978, 1997, FUND 1992, AFS 2001, International Convention for the Control and Management of Ships' Ballast Water and Sediments 2004, SENSREC 2009, OPRC 2016.

1.4 Marine Fisheries treaties: FAO Code of Conduct for Responsible Fisheries.
1.5 Maritime safety rules and regulations: SOLAS and COLREG, Marine accidents, case study on major marine accidents.
1.6 Marine Scientific Research: Legal problems and Solution under The Geneva Convention, UNCLOS and other Maritime Laws.

2. Ocean governance and management, Ocean Policy: status in Bangladesh.
3. Blue Economy: concepts, global blue economic prospects, blue economic sectors, blue economy initiatives in Bangladesh, present status and roadmaps, role of ocean science in supporting blue economy.
4. Maritime defense and law enforcement authorities: Navy and coastguards, Bangladesh Navy and Coast Guard: their roles and jurisdictions.
5. Unusual uses of the sea Piracy, Dacoity, Human trafficking, Refugee movement and other contemporary cases.
6. Geo-politics, Political Oceanography, Geo-economics and Geo-strategy: Conceptual Considerations.
7. Geo-political Strengths and Weakness of Bangladesh, Geo-politics of Bangladesh: Studies in Locational Significance.
8. Relationship of Bangladesh with SAARC, ASEAN, Europe and Middle-East/OIC Countries. Bilateral Relationships with China, India, Japan and USA.
9. Connectivity and Regional Trade, FTA agreement, ASEAN, BCIM, BIMScTEC, RECP. Indian Ocean Rim Association (IORA), One Belt One Road (OBOR) and Maritime Silk Route.
10. Hydro-Politics of Bangladesh: History, Farakka Problems, Transboundary River Disputes, Tipaimukh Dam and Interest of Lower Riparian Bangladesh, Teesta, Yarlung Tsangpo and Other Water-Sharing Problems of the Region.
11. Geopolitics and military interests, Maritime security of Bangladesh.
12. Geo-political and Geo-strategical Aspects of Indo-Bangladesh Connectivity: Transit, Transshipment Problems, Asian Highway and Asian Railway, Port Facilities for Neighbouring Countries and Security of Bangladesh; Sub-Regional Groupings.

Suggested Reference Text Books:

- ✓ The Oceans: Key issues in marine affairs, by Hance D Smith (Ed), Springer-Science+ Business Media. 2004.
- ✓ Case studies in Oceanography and Marine affairs, by Garry Bearman (Ed), Pergamon Press. 1991
- ✓ Sea Power. The History and Geopolitics of the World's Oceans. By Admiral James Stavridis, Penguin Press. New York City, 2017.
- ✓ The Geopolitics of South Asia: From Early Empires to the Nuclear Age (3rd Edition) by Graham P. Chapman, 2009.
- ✓ The Geopolitics of Energy in South Asia by Marie Lall, 2009.
- ✓ The China Pakistan Axis – Asia's New Geopolitics (1st Edition) by Andrew Small, Oxford University Press, 2015.
- ✓ The Ganges Water Dispute by B. M. Abbas, 1982.
- ✓ Hydropolitics by Ohisson, 1995.

Course Code: OCN M105	**Credit:**3
Course Title: Advanced Physical Oceanography	

Rationale: Oceanographers must have enough knowledge on ocean dynamics, its features and different properties which controls the ocean environment. All of these are dealt by the subject Physical oceanography.

Course Objectives: The objectives of the course are:

- ✓ To understand physical features of the ocean ranging from microscopic turbulence to global circulation.
- ✓ To learn the variation of physical parameters which controls the ocean environment, ocean dynamics and ocean characteristics.
- ✓ To develop the knowledge of the dynamics of physical oceanography.

Learning Outcomes: Having successfully completed this course, students will be able to:

- Explain physical features of the ocean ranging from microscopic turbulence to global circulation.
- Acquire knowledge on variation of physical parameters which controls the ocean environment, ocean dynamics and ocean characteristics.
- Understand the dynamics, present advances and future of physical oceanography.

Syllabus Contents:

1. Advances in Physical Oceanography
   1.1 Basic Advances in Physical Oceanography
   1.2 Future of Physical Oceanography in the World

2. Physical properties of sea water
   1.1 Distribution of temperature, salinity, conductivity, pressure etc. in ocean: Surface distribution, Vertical distribution and profiles, Meridional distribution
   1.2 Optical Properties of sea water
   1.3 Sound in Sea water, Underwater Telemetry
   1.4 Viscosity and Surface Tension

3. Ocean Wave
   6.1 Wave theories
   6.2 Wave energy, wave generation and breaking, Effect of wave on Shore and coastal area, Utilization of wave energy
   6.3 Formation of Wind waves and swells
   6.4 Tsunami and other long wave
   6.5 Rossby wave & Kelvin wave, Long shore wave

4. Ocean circulation
   7.1 Theories of global circulation, Coriolis force, Ekman's spiral, Oceanic fronts
   7.2 General circulation in Ocean and air, Global energy balance, major ocean currents
   7.3 Vertical circulation: Upwelling and sinking
   7.4 El Niño, La Niña, IOD: their cause and effect on world weather

5. Tide and Tide Generating Forces

8.1 Tide Generating Forces: centrifugal force and gravitational attraction, tidal potential etc
8.2 Theories of Tide: Dynamic theory, Equilibrium Theory
8.3 Effects of tide on Estuaries, Rivers and Other Coastal Areas, Tidal Bore

Suggested Reference Text Books:

- ✓ The Oceans: Their Physics, Chemistry, and General Biology, by H. U. Sverdrup, M. W. Johnson, R. H. Fleming, Prentice Hall (1942), ISBN: 0136303501.
- ✓ General Oceanography: an Introduction by Dietrich, Kalle, Krauss and Siedler, John Wiley &Sons (1980, Second Edition).
- ✓ Descriptive Physical Oceanography, by G. L Pickard, Elsevier Science Ltd, ISBN: 0080379524.
- ✓ Introduction to Physical Oceanography, by RH Stewart, University Press of Florida (2009), ISBN: 1616100451.
- ✓ Principles of Physical Oceanography, by G. Neumann, Prentice-Hall, ISBN: 0137097417.
- ✓ Elements of Physical Oceanography, by H. J. McLellan, Pergamon Press, ISBN: 0080113206.
- ✓ Elements of Physical Oceanography, by John Steele, Academic Press, ISBN: 0080964850.
- ✓ Physical oceanography of coastal and shelf seas, by B Johns, Cambridge University Press, ISBN: 0521701481.
- ✓ Ocean Circulation (Second Edition) by A. Colling. Published by The Open University Course Team, 2001.
- ✓ Waves, Tides and Shallow-Processes (Second Edition) by J. Wright, et al. Published by the Open University Course Team, 2000.

Course Code: OCN M107	**Credit:** 3
Course Title: Marine Geology and Geophysics	

Rationale: This course has been designed to provide knowledge of marine geology and geophysics to understand:

- The structure of the earth beneath the oceans
- The processes that shape the seafloor
- The interactions between geological and biological systems
- The history of ocean circulation patterns and climate change preserved in seafloor and lake sediments, corals, ice sheets, and other natural archives
- Climate variability and impacts
- Advanced training in marine geophysical exploration techniques, mathematical modelling, geodynamics, coastal processes, and palaeo-oceanography are also included.

Course Objectives: The objectives of the course are to develop knowledge on:

- The tectonics and dynamics of active plate boundaries and continental margins including sub-seabed fluid flow processes.
- Continental slope and deep-water sedimentation processes including mass-wasting, geohazards, environmental geology and ecosystems.
- The role of fault system growth and evolution in crustal deformation.
- Coastal and continental shelf sedimentary environments and processes including the interaction with engineering structures.
- High resolution quantitative and qualitative analysis of the seabed and sub-surface by geophysical techniques.

Learning Outcomes:

- Knowledge and understanding of the marine geosciences/ocean sciences.
- Knowledge and understanding of marine georesource exploration.
- Knowledge and understanding of ocean bottom seismology, high resolution sea floor imagery, and the analysis of cores and other sea-bottom samples.
- Potential for original and independent research on a marine geophysical and geological topic.
- Apply marine geology and geophysics in environment and geohazards assessment and climate model development.

Syllabus Contents:

Theory

1. Dynamics of convection in the mantle that drives the motion of tectonic plates. Tectonic, volcanic, and hydrothermal activity at the mid-ocean ridges, ocean basins and the characteristics of the oceanic crust.
2. Sediments and sedimentation process from the source to sink. Interactions of continental and oceanic geologic processes. Coastal processes and the structure of continental margins. Interactions between earth's processes, the oceans, and ecosystems.
3. Determination of ground water and saline water interface in the coastal plain. Geological processes and its impact on the chemistry of the oceans and the distribution of organisms.
4. Application of gravity, magnetic, heat flow, and seismic methods to study the structure of the earth beneath the oceans, to explore georesources beneath the ocean. Process and application of drilling and geophysical logging for ocean exploration.

Learning of Research tools and techniques:

1. To explore the seafloor, marine geologists and geophysicists use a wide range of research tools and techniques, including field work, laboratory analyses, and numerical modeling.
2. Many go to sea on research vessels to collect data and samples, either remotely using geophysical tools, rock dredging, sediment coring, remotely operated vehicles (ROVs), or autonomous underwater vehicles (AUVs), or directly using a submersible.
3. Instruments used in marine geophysics – Gravimeter, magnetometer for marine studies, echosounder, side scan sonar and sparker. Hydrography – position fixing,

depth measurement and sea bed mapping technique, hydrographic chart.

Suggested Reference Text Books:

- ✓ Introductory oceanography (5th ed), 1988 Thurman, H.V., Columbus Mercill Publ. Co, Ohio.
- ✓ Oceanography (5th ed), 1990 Grant Gross, M., Englewood Cliffs, N.J. Prentice Hall.
- ✓ Marine Geology, 1982 James P. Kennet, Prentice Hall INC Englewood, Cliffs, N. J. 07632.
- ✓ Earth Science, 1985-Mamowitz and Spaulding, Heath and Company, Heath.
- ✓ Principles of Geophysical Prospecting, 1976 Dobrin, M. B., Mc. Graw Hill.
- ✓ Geophysical Prospecting for Oil, 1976 Nettleton, L. L., McGraw Hill.
- ✓ Exploration Seismology (Vol. 1 and 2) 1982, 1983 Sheriff, R. E. and Geldant, L. P., Cambridge Univ. Press, U.K.36
- ✓ Developments in Solid Earth Geophysics (Vol.5) Spectral analysis in geophysics, 1974 Bath Markens.
- ✓ Seismic Prospecting Instruments (Vol.1) 1972 Evenden, B. S., Stone, D. R. and Anstey, Gebrudev Borntraege, Berlin.
- ✓ Plate Tectonics and Crustal Evolution. Kent C. Condie. 1982 Pergamon Press

Course Code: OCN M109	**Credit:**3

Course Title: Ocean Governance and Marine Spatial Planning (MScP)

Rationale: This course has been designed to explore concept, processes and institutional frameworks for ocean governance and MScP.

Course Objectives: The objectives of the course are to:

- Explore the concept of ocean governance
- Explore the concept of MScP
- Opportunities and challenges of ocean governance and MScP in Bangladesh

Learning Outcomes: Having successfully completed this course, students will be able to:

- ✓ Student will learn the concept of ocean governance and MScP
- ✓ they will learn the challenges and opportunities for good ocean governance and implementing the MScP in Bangladesh

Syllabus Contents:

Ocean governance:

1. Concept and philosophy of governance, good governance and ocean governance.
2. Components of ocean governance; three components, namely, institutional framework, legal framework and tools of implementation.
3. Institutional frameworks for ocean governance; National, Regional and Global Institutions.
4. Challenges and opportunities in ocean governance towards blue economy in Bangladesh

Marine Spatial Planning (MScP):

1. Marine Spatial Planning: concepts, process, and implementation
2. The worldwide status and trends of MScP
3. MScP towards Ecosystem based management
4. Approaches for Marine Spatial Planning
5. Monitoring and evaluating the Performance of MScP
6. Improving the Effectiveness of MScP
7. Key challenges and opportunities in implementing MScP in Bangladesh

Suggested Reference Text Books:

- ✓ Marine Spatial Planning: a step-by-step approach toward ecosystem-based management. Intergovernmental Oceanographic Commission and Man and the Biosphere Programme. IOC Manual and Guides No. 53, ICAM Dossier No. 6. Paris: UNESCO. 2009 (English).
- ✓ Ehler, Charles; A Guide to Evaluating Marine Spatial Plans, Paris, UNESCO, 2014. IOC Manuals and Guides, 70; ICAM Dossier 8.

Course Code: OCN M111	**Credit:** 3
Course Title: Climate and Atmospheric Science	

Rationale: This course has been designed to explore the climate and atmospheric science in Oceanographic study and research.

Course Objectives: The objectives of the course are to:

- Status and prospect of cultivable coastal and marine resources.
- Know the concept and components of weather and climate.
- Know the global climate pattern
- Know the extreme climate events

Learning Outcomes: Having successfully completed this course, students will be able to:

- Students will understand the different components of weather and climate
- They will get knowledge on the climatic process on the marine ecosystem

Syllabus Contents:

1. **Introduction to Weather and Climate:** Atmospheric composition and structure, clouds, precipitation, and atmospheric motion and winds. Organized weather systems, including air masses, fronts, and severe weather. Discussion of global climates includes atmospheric and ocean circulation, wind systems, climate classification, and climate change.
2. **Climatology:** Climatology from local to global scales. Topics include radiation/heat exchanges, the hydrologic cycle, global climate patterns, climate change, measurement and data sources, relationships of climate with ecosystem processes, and human activities, and climate forecasting
3. **Weather Analysis and Forecasting:** The collection, display, and application of weather data. The use of meteorological instruments, codes, maps, atmospheric soundings, and thermodynamics diagrams. Interpretation of weather maps using basic meteorological principles.
4. **Atmospheric Hazards:** The causes, impacts and policies regarding hazards due to atmospheric phenomena, including hurricanes, tornadoes, windstorms, extreme

temperature and precipitation events, and climate change.

5. **Satellite Meteorology and Climatology:** Application of satellite remote sensing in meteorology and climatology. Applications include clouds, atmospheric water vapor and precipitation, the Earth's radiation budget, sea and land surface temperatures.

6. **Climate variabilities:** Global and local climates; Maritime and continental climate; the Asian Monsoon; El-Nino Southern Oscillation; Indian Ocean Dipole; climate of Bangladesh.

7. **Climate change:** Causes and impacts of climate change; Global Warming, Carbon cycle, carbon emission and sequestration, Sea Level Rise; Arctic climate and sea ice; ice caps and permafrost; glaciers and world water resources; climate predictions.

Suggested Reference Text Books:

- ✓ Atmosphere, Weather and Climate, 8th Edition. By Roger Graham Barry & Richard J. Chorley. Routledge, 2003.
- ✓ Climates and Weather Explained. By Edward Linacre & Bart Geerts. Routledge, 1997.
- ✓ The Oceans and Climate, 2nd edition. By Grant R. Bigg. Cambridge University Press. 2003.

Detail Syllabus
Semester - 2

Course Code: OCN M201	**Credit:** 3
Course Title: Ocean Mapping	

Rationale: This course has been designed to explore concept and mastering not only the elements of mapping the seabed, but also becoming adept at such topics as the geologic characterization of the seabed; mapping of living ocean resources and habitats; and development of the tools, sensors and techniques used to map the oceans.

Course Objectives: The objectives of the course are to:

- ✓ Explore the concept of mapping the seabed;
- ✓ Visualization of the geologic characterization of the seabed;
- ✓ Develop the knowledge of mapping of living ocean resources and habitats;
- ✓ To understand the tools, sensors and techniques used to map the oceans;
- ✓ To learn the various techniques to create the definitive map of the world ocean;
- ✓ To understand the attributes and features of Geographical Information system;
- ✓ To understand the basic concepts of using GIS in mapping the earth in spatial terms and populating the GIS's system to access data.

Learning Outcomes: Having successfully completed this course, students will be able to:

- ✓ Understand the Geodesy and Positioning for Ocean Mapping;
- ✓ Understand the projection systems and transformation of surfaces;
- ✓ Explain the attributes and features of Geographical Information system;
- ✓ Acquire knowledge on different mapping tools;
- ✓ Explore the concept of mapping the seabed, living ocean resources and habitats, geologic characterization of the seabed;
- ✓ Explain basic concepts of using GIS in mapping the earth in spatial terms and populating the GIS's system to access data;
- ✓ Create and access data in the GIS's system using an appropriate software package;

Syllabus Contents:

1. **Mapping in General:** What is ocean mapping; History of ocean mapping, characteristics of maps; Key ingredients for the mapping the earth ocean; Types of Maps and Map Specification. Mapping standards; Maps as a summary of the world, Basic information of a map, the purpose of the map, steps in the production of map, marginal information of a map.

2. **Geodesy:** Introduction to geodesy; Coordinate systems; Frames and datums; Geodetic transformations and associated computations; Shape and size of the Earth as a sphere; ellipsoid of revolution and geoid; Latitude and longitude on the ellipsoid and the sphere; Local geodetic reference frames; Terrestrial reference systems and reference frames; Datum transformation techniques; Vertical datums; Modern geodetic reference systems and datums; Computations on the sphere, Computations on the ellipsoid.

3. **Elements of Cartography.** Definition of a map and a nautical chart; Characteristics of maps and charts; Concept of scale; Categorization of maps/charts in relation to scale and purpose; Representing the figure of the earth on a flat surface; Abstract representation and generalization; Symbolization, Static & dynamic maps/charts.

4. **Map Projections:** Map/chart projections; projection properties and associated

distortions; Basic projection techniques; Categories of map/chart projections (cylindrical, conical, azimuthal); Properties of map/chart projections (conformal, equivalent, equidistant); Projection formulae and planimetric coordinates; The UTM projection system.

5. **Study of Map Distortions:** Definition of Scale Factor; Principal directions; Distortions in distances, areas and angles associated with specific map projections (Mercator, Transverse Mercator, Lambert conformal conic); transfer the information from the surface of a 3-dimensional; irregularly shaped sphere (the Earth) to a 2-dimensional flat 'piece of paper'.

6. **The Basics of GIS:** Introduction to GIS; Mapping Information; Vector and Raster map, The geographic approach in GIS and ArcGIS platform, Create and share a map with ArcGIS; GIS data models, Symbology and visualization; ArcGIS features, attributes, catalogue, tools and database; Finding, identifying, and selecting features; Geoprocessing in analyses; Common analysis tasks; Perform spatial analysis with common analysis tools; Attribute queries; Spatial queries, Maps use basic shapes or data types (e.g. points, lines, polygons, grids, and triangles).

7. **Ocean Mapping Tools:** Learning of different ocean mapping tools like: Generic Mapping Tools, ARCGIS, Surfer, Fledermause etc. Metadata for analog and digital data and chart products; ENC, SENC and ECDIS IHO standards for charts and ENC production.

8. **Visualization of Ocean Floor or Relief representation:** Concept of mapping the seabed; Bathymetric Spatial Analysis, Gridding from xyz data, Rationale for terrain and sea bottom representation; Mapping of living ocean resources and habitats; Creation of DTM, TIN, contouring, interpolation, sounding selection, sorting, Terrain Analysis; Data presentation, Seafloor characterization; Mastering the geologic characterization of the seabed, Relative and absolute accuracy in contouring,

9. **Derived Bathymetry:** Satellite Derived Bathymetry and public domain bathymetric data, use of GEBCO & ETOPO gridded data in ocean mapping, Remote sensing – application to charting.

10. **Field Work/ Hydrographic Project Survey:** Field Work/ Hydrographic project survey on Bathymetric Data collection by using singlebeam/ multibean echosounder; Bathymetric survey for ocean mapping; Survey planning; Survey preparation; Data acquisition; Data processing; Survey project reporting.

11. **Ocean Mapping Project:** Project work on mapping ocean and coastal area using ARCGIS or any other GIS tool applying coastline and topographic data bathymetric data Oceanographic information

Suggested Reference Text Books:

- ✓ Introduction to Geodetic Datum and Geodetic Systems; Authors: **Lu**, Zhiping, **Qu**, Yunying, **Qiao**, Shubo
- ✓ The Concepts Geodesy, 2nd Edition: **Authors:** P. Vanícek E.J. Krakiwsky
- ✓ Textbooks: Mapping Technology Review: http://seafloor.csumb.edu
- ✓ Web Resources: Ocean Mapping Group @ U. New Brunswick http:// www.omg.

unb.ca/omg/

- ✓ Cartography and Geographic Information Science – Editor: Leitner, M.
- ✓ Beyond Mapping Compilation Series by Barry, J.K.
- ✓ "Map Projections: A Working Manual"
- ✓ "Geospatial Analysis – A comprehensive guide"
- ✓ The ArcGIS Book: 10 Big Ideas about Applying The Science of Where – by ESRI
- ✓ Instructional Guide for The ArcGIS Imagery Book – by ESRI
- ✓ *Required:* Getting to Know ArcGIS (4th Edition), Authors: Michael Law, Amy Collins Publisher: ESRI Press (July 2015, © 2015)
- ✓ ArcGIS Tutorial by ESRI. http://esripress.esri.com
- ✓ TEXTBOOK: Getting to Know ArcGIS; http://esripress.esri.com/book Resources/ index.cfm?event=catalog.book&id=16
- ✓ Mapmaking Cook Book: BSMRMU

Course Code: OCN M203	**Credit:**3

Course Title: Numerical Methods and Ocean Modelling

Rationale: Numerical Methods and Ocean Modelling is a very appealing subjects in the recent decades. As the ocean in the earth system is a vast area to cover by the in situ observations, the numerical techniques and the modelling is much suitable techniques to know this oceanic realm. Therefore, this course is very crucial for the students of the oceanography to forecast, hindcast, and learn the earth system processes through the modelling.

Course Objectives: The objectives of the course are to:

- ✓ To learn about different numerical techniques and the approximations for ocean modelling
- ✓ To understand the model grid, parameterizations, governing equations, and the validation of the ocean model
- ✓ To develop simple ocean model and simulate the existing ocean models.

Learning Outcomes: Having successfully completed this course, students will be able to:

- ✓ Understand the most advanced theories and techniques for numerical models of atmospheric and oceanic phenomena.
- ✓ Utilize the finite difference, finite volume, and finite element techniques for solving partial differential equations, atmospheric forcing functions, fundamental laws in the model
- ✓ Draw conceptual simple ocean model and able to work with existing ocean models like ROMSc, MOMSc, HYCOM, etc.

Syllabus Contents:

1. Introduction: Fundamental laws - governing equations; basic balance equations for mass, momentum & energy; equation of state; approximations and representations; boundary conditions.

2. Numerical methods: Iterative process, Newton - Raphson method to solve non-linear equations, Finite difference methods: Backward, centred& forward

differences; Implicit and explicit finite difference schemes; Taylor's series; computation errors, leapfrog scheme, trapezoidal implicit scheme, Crank - Nicolson schemes, CFL criteria: Stability criteria, computational instability; Fourth order Runge-Kutta method to solve Ordinary Differential Equations (ODE).

3. Concepts of models, modeling of ocean processes, reduced gravity model, various types of grids, computation of time step for integration, physical processes involved in modeling of upper ocean, barotropic and baroclinic instabilities, spin up. Development of models - advantage and limitations of models- numerical storm surge models. Examples of Ocean-atmosphere coupled models. Data inputs – interpretations. Model validation.

4. Familiarization with the Ocean General Circulation Models (OGCM), Regional Ocean Modelling System (ROMSc), Modular Ocean Model (MOM), and Hybrid Coordinate Ocean Model (HYCOM)

Lab/practical:

5. Numerical differentiation & integration- Numerical solution of partial differential equations; Mathematical models – equations - Computation of suspended and bed load sediment transport Numerical models – Discretization of governing equations using various schemes – Advection and Diffusion Forecast of various oceanic parameter using Governing equations – Buoyancy – Inertial currents – Ekman Currents Familiarization of IIT Storm Surge Model - Presentation and interpretation of model results.

Suggested Reference Text Books:

- ✓ Introductory Dynamical Oceanography: Stephen Pond George L. Picard, 1986, 329p.
- ✓ Modeling Marine Processes: Phil Dyke, Prentice Hall,1996, 152p.
- ✓ Computer Modeling in Atmospheric and Oceanic Sciences: Peter Muller and Hans VonStorch, springer, 2004, 304p.
- ✓ Numerical Modeling of Oceans and Oceanic Processes: Lakshmi H. Kantha & Carol Anne Claysor, Academic Press, 2000,943p.
- ✓ Ocean Modeling for Beginners using Open Source Software: Jochen Kampf, Springer, 2007, 173p.
- ✓ Dynamics & Modeling of Ocean Waves, Komen et al., Cambridge University Press,1994, 532p.
- ✓ Introduction to the Modeling of Marine Eco-systems: W. Fennel & T. Newmann, Elsevier, 2004.
- ✓ Numerical Modeling of Ocean Dynamics: Z Kowalik& T. S. Murthy, World Scientific, 1995.
- ✓ Modeling and Prediction of the Upper Layer of the Ocean: E B Kraus, Pergman Press,1977, 325 p.
- ✓ Ocean Circulation Physics: M E Stern, Academic Press, 1975, 246p.
- ✓ Numerical Modeling of Marine Hydrodynamics – Application to Dynamic Physical Processes: H G Ramming & Z Kowalik, Elsevier,1980.
- ✓ Numerical Prediction and Dynamic Meteorology: Haltiner, George J.,and Roger T. Williams., 2nd Ed., Hoboken, NJ: John Wiley & Sons, 1980.
- ✓ Numerical Ocean Circulation Modeling. Haidvogel, Dale B. and Aike Beckmann..River Edge, N J, Imperial College Press,1999, 318p.

- ✓ Ocean Circulation and Climate: Observing and Modeling the Global Ocean: Gerold Sielder, John church and Jon Gould, International Geophysical Series, Vol. 77, Academic Press, 2001,715p
- ✓ Coupled Ocean Atmosphere Models: Nihoul, J C J., Elsevier 1985.
- ✓ Røed, L. P., 2019: Atmospheres and Oceans on Computers: Fundamental Numerical Methods for Geophysical Fluid Dynamics. Springer Textbooks in Earth Sciences, Geography and Environment, 275 p., doi: 10.1007/978-3-319-93864-6.
- ✓ Ocean Modelling for Beginner: Using Open-Source Software. Kaempf, Jochen, Springer, 2007, 173p

Course Code: OCN M205	**Credit:**3

Course Title: Advanced Marine Biotechnology and Therapeutics

Rationale: This course is designed to provide advance concepts a Marine Biotechnology and its therapeutic application

Course Objectives: The objectives of the course are to:

- Conceptualize general knowledge on Marine Biotechnology
- Acquire general knowledge on different areas of Marine Biotechnology
- Acquaint with general techniques used in Marine Biotechnology.
- ✓ To introduce Biotechnology together with application of biotechnology for industrial products, scope of marine biotechnology.
- ✓ To introduce marine biotechnology, types of marine environment and their interaction with marine life; air-sea interaction.
- ✓ To introduce the necessity of restoring marine ecosystems.
- ✓ To make students aware of the methods of natural products synthesis and synthetic methodology for bioactive compounds

Learning Outcomes: By the end of this course students would be able to:

- Describe various aspects of Marine Biotechnology
- Explain the scope and importance of study of Marine Biotechnology
- Describe the current methods of Fisheries and Marine Biotechnology to be used in Biotechnology
- Understand the scope of marine natural products and biotechnology application.
- Understand marine resources (biological and chemical diversity), history of marine natural products, marine natural product classes.
- Appreciate the chemical ecology of marine invertebrates.
- Understanding the classification of chemical metabolites and chemical defense systems.

Syllabus Contents:

1. Marine biotechnology and its contribution to economic and social prosperity, how these advances improve our understanding of marine life and facilitate access to and study of marine organisms, ecosystems and their largely untapped potential.

2. Important concepts of the water environment, including water chemistry, components of seawater and transmission of energy.
3. Simulation modeling and ecological applications that offer solutions to complex management problems of water resources.
4. Factors that govern primary production in the oceans. Challenges associated with

the development of these resources, which exist in complex ecosystems and are distributed throughout a vast shared environment.
5. Areas that will benefit from greater attention as policies are developed to support marine biotechnology.
6. Current advances in marine biotechnology in various drug development.
7. Diversity and evolution of secondary metabolism in marine organisms, classes of marine natural products
8. Isolation, structure and biosynthesis of four main classes of secondary metabolites: polyketides
9. Application of genomics to secondary metabolism. Identification of secondary metabolism gene clusters
10. Fluorescent proteins from oceans as advanced imaging tools for biomedical research

Suggested Reference Text Books:

- ✓ Introduction to Biotechnology, 3rd ed. Author: William J. Thieman, Michael A. Palladino, Publisher: Pearson, 2012. Cambridge, UK
- ✓ Molecular Biotechnology: Principles and Applications of Recombinant DNA (4th Edit.)- Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten.
- ✓ A Textbook of Biotechnology- R. C. Dubey
- ✓ Handbook of Marine Microalgae: Biotechnological Advances- Se-Kwon Kim (Ed.)
- ✓ Springer Handbook of Marine Biotechnology- Se-Kwon Kim (Ed.)
- ✓ Biotechnology: Recent Trends and Emerging Dimensions- Atul Bhargava, Shilpi Srivastava
- ✓ Recent Advances in Marine Biotechnology Volume 3 – Milton Fingerman et al., 1999.

Course Code: OCN M207	**Credit:**3

Course Title: Ocean and Coastal Hydrodynamics

Rationale: This course is designed for the students to learn about different aspects of Hydrodynamical process affecting Ocean and Coastal waters.

Course Objectives: The objectives of the course are to:

- To learn about water circulation process, Dynamics of tides, waves, Current and their impact on coastal and marine environment.
- To learn about implication, forecasting and modelling of important ocean hydrodynamical process affecting life.

Learning Outcomes: Having successfully completed this course, students will be able to:

- Have knowledge on features of coastal waters and oscillation.
- Have knowledge on data analysis and processing in the field of ocean modelling.
- Holistic general knowledge on forecasting, problem formulation and solution for tide, wave, current, circulation etc.

Syllabus Contents:

1. Introduction: Features of coastal waters, Coastal water Oscillation, Fluid and particle concept, Kinematics and Dynamics of water particle, Conservation law.

2. Particle velocity and acceleration under wave transport. Particle Displacement.

Orbital motion of water particles at different water depth. Derivation for potential energy and kinetic energy.

3. Dynamics of Coastal and Ocean waves: Short surface waves, Long surface wave, Deep ocean waves, Problem formulation for waves and solution, Refraction in wave, Wave modulation and breaking, Wind induced wave statistics, Spectral properties of wave.

4. Wave shoaling, Wave diffraction, Wave breaking, Wave forces on coastal structures.

5. Currents: Classification, Source, Interactions of waves and current, Modelling of Coastal circulation, Current velocity varying depth.

6. Variation of sea level, Variation of mean water level due to tides and waves, Strom surges in coastal zone.

7. Ecological implication of altering the hydrodynamics in marine environment.

8. Bay of Bengal coastal hydrodynamics.

9. Application of Numerical models tools in Coastal Hydrodynamics and Morphology.

10. Coral reef hydrodynamics.

11. Response of biological species to changing Ocean and Coastal Hydrodynamics condition.

Suggested Reference Text Books:

- ✓ Hydrodynamics of Coastal Zone, Stanislaw R. Massel, Elsevier Oceanography Series 48, ISBN 0-444-87375-9 (Vol.48), 1989.
- ✓ Advances in Coastal and Ocean Engineering, Philip L.-F. Liu, World Scientific Publishing, Vol.05, 1999.
- ✓ Marine Hydrodynamics, J.N. Newman, 40th addition, The MIT Press, Cambridge, Massachusetts, London, England, 2017

Course Code: OCN M209	**Credit:**3

Course Title: Sea Farming Technology

Rationale:

This course has been designed to explore the potential and opportunity of coastal aquaculture and mariculture in Bangladesh context towards sustainable blue economy.

Course Objectives:

The objectives of the course are to identify:

- Status and practices of coastal and marine aquaculture in World Ocean.
- Status and prospect of cultivable coastal and marine resources in Bangladesh.
- Gap analysis for the technological advancement in mariculture between Bangladesh marine waters and World Ocean.
- Culture techniques of marine cultivable species and plant.

Learning Outcomes:

- Grow out and culture methods of different marine organisms and plants.
- Sustainable development and culture practice of marine species.

Syllabus Contents:

1. An overview of technological advancement in sea farming and shore-based aquaculture in different parts of the world.
2. Resources available in Bangladesh for shore-based aquaculture and sea farming. Traits of important cultivable fish and shellfish (seabass, mullet, milkfish, grouper, cobia, snappers, tiger shrimp, white shrimp, mud crab, mussel, clam, oysters (edible and pearl oyster), lobster, seaweeds.
3. Shore based/coastal aquaculture system: traditional, semi- intensive, intensive aquaculture practice of commercially important species of fish and shellfish (e.g. Pearl culture).
4. Methods of Fish and Shellfish Culture; rafts, racks, cages, poles and ropes. Water quality parameters and soil quality management. Estimation of growth, survival and productivity. Fouling organisms in cages and pens. Material, apparatus and machinery for shore-based aquaculture and sea farming. Estimation of feed intake. Growth and health monitoring technologies.
5. Seaweed culture: Seaweed resources of Bangladesh. Status and prospects of seaweed farming in Bangladesh. Major brown, red and green seaweed culture techniques. Hatchery techniques for seaweed farming.
6. Sea ranching: Concept and practices of marine ranching all over the world. Prospect of marine ranching in Bangladesh.
7. Integrated Multitrophic Aquaculture (IMTA): Concept and practices of IMTA in mariculture. Prospect of IMTA in Bangladesh coastal waters.

Suggested Reference Text Books:

- ✓ Coastal Aquaculture Engineering by S. N. Ghosh, A. N. Bose, C. T. Yang, A. Mitra. ISBN 0521417678, 9780521417679.
- ✓ Coastal Aquaculture & Mariculture by Athithan, ISBN 9789388668958
- ✓ Tropical Mariculture 1st Edition by Sena S. De Silva (Editor), ISBN-13: 978-0122108457

Course Code: OCN M202	**Credit:**2

Course Title: Viva-voce

(A regular student must appear at the viva-voce as per course curriculum. At the end of the semester final examination, the Examination Committee of the Department shall hold the viva-voce where the students will be examined for the whole semester.)

Detail Syllabus
Semester - 3

Course Code: OCN M301	**Credit:** 2
Course Title: Seminar in Oceanography	
Each student has to appear for two seminar presentations on current research in various fields of oceanography, selected by the department/course teacher, related to his/her MSc thesis/project.	

Course Code: OCN M302	**Credit:** 2
Course Title: Field Work	
Students will go for field work either in estuarine, coastal areas or in a cruise on ocean going vessel (ORV) in the offshore and deep sea area. They will collect in-situ data and samples for lab work. After lab work they will submit a detail report on it. They will be marked on oceanographic instrument handling, sample collection, preservation, data analysis and report preparation.	

Course Code: OCN M303	**Credit:** 3
Course Title: Lab Work	

Rationale:

This course is designed for the students so that they become trained and skilled in Laboratory analysis after field sample collection, handling and analysis data in aspects of physical, chemical, biological and geological oceanography.

Course Objectives:

The objectives of the course are:

- To develop skill in sample collection and preservation.
- To develop skill in laboratory analysis of sample.

Learning Outcomes:

Having successfully completed this course, students will be able to:

- Hand skill in sample preservation and analysis.
- Holistic general knowledge on different parameter analysis and collection of data in the aspects of physical, chemical, biological and geological oceanography and also marine microbial study.

Syllabus Contents:

1. Determination of DO, pH, Salinity, temperature, Density, Conductivity, Fluorescence, Chlorophyll, turbidity, BOD, COD in laboratory and optical sensor method.
2. Determination of Nitrate, Nitrite, Phosphate, Ammonia and Silica in titrimetric and spectrophotometric method.
3. Determination of trace, major and minor elements of seawater.
4. Growth and Microbiological study of selected marine microorganisms.
5. Sediment analysis.

Suggested Reference Text Books:

- ✓ An Introduction to the Chemistry of the Sea, Michael E. Q. Pilson, 2nd Edition, Cambridge University Press, 2013.

- ✓ Chemical Oceanography, Frank J. Millero; CRC Press, 2013.
- ✓ Seawater: Its Composition, Properties and Behaviour, John Wright and Angela Colling, Second Edition; Butterworth-Heinenmann, 2003.
- ✓ Data Analysis Methods in Physical Oceanography, Elsevier, Richard E. Thomson and William J. Emery, 3rd Edition, 2014.
- ✓ A practical handbook on seawater analysis, Fisheries research board of canada, Ottawa, 1972, J.D.H. Strickland and T.R. Parsons.
- ✓ A Manual of Chemical & Biological Methods for Seawater Analysis, Elsevier, 1st Edition, Timothy Parsons,1984.
- ✓ Analysis of Seawater, Elsevier, Crompton, 1989

Course Code: OCN M304	**Credit: 9**
Course Title: Project Work (Project Report-7; Project Report Presentation & Viva-2)	
The students will gain a broad-based, in-depth knowledge of physical, chemical, biological geological, and ecological processes in the ocean coupled with the technical skills necessary to contribute to the exploration of the marine environment and the management of its living resources. In project work the practical skills and the analytical expertise required to monitor and manage the global ocean system will be emphasized.	

Course Code: OCN M305	**Credit:** 12
Course Title: Thesis (Thesis-10; Thesis Presentation/Defense-2)	
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 an oral presentation. **General Guides:** 1. Thesis/project 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.	