Bangladesh Maritime University

Faculty of Earth and Ocean Sciences

Department of Oceanography and Hydrography

Course Curriculum for

B.Sc. (Honours) in Oceanography Programme

Fourth Amendment: Effective from the Academic Session: 2024-2025

Curriculum Committee

A curriculum committee was formed vide memorandum no. BMU/Reg:/Council/Syndicate-378/2025/948 dated 29 May 2025 prepared the curriculum of B.Sc. (Honors) in Oceanography. The committee comprises with the following members:

Ser	Name	Sig	Remarks
a.	**Cdre Sheikh Shahid Ahmed, (H1), psc, BN** Dean (FEOS) & Head of the Department Department of Oceanography and Hydrography Faculty of Earth and Ocean Sciences Bangladesh Maritime University		President
b.	**Dr. K M Azam Chowdhury** Associate Professor Department of Oceanography University of Dhaka.		Member
c.	**Dr. Mohammad Tanzil Hasan** Associate Professor (Mathematics), Faculty of General Studies, Bangladesh Maritime University		Member
d.	**Md. Enamul Hoque** Associate Professor, Oceanography, Department of Marine Sciences, University of Chittagong.		Member
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Course Curriculum of
Bachelor of Science (B.Sc.) in Oceanography

Introduction to the Bangladesh Maritime University

1.Bangladesh owns a sea area of 1,18,813 km^2 in the Bay of Bengal that 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 perspective, efforts are being made by the Government to produce well educated manpower with very sound professional knowledge in the maritime sector.

In order to create effective human resources, the first-ever specialized university, Bangladesh Maritime University (BMU), was established on 26 October 2013. The Motto of this university is "We strive for Maritime Excellence". The university aims at bringing all maritime professionals to a common platform to share knowledge and carryout research for the advancement of the maritime sector and develop effective human resources in this sector.

2. Vision of the University

Envision promoting and creating 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.

3. Mission of the University

BMU is committed to provide quality education based on state-of-the-art technological support responsive to the emerging challenges at home and abroad. BMU 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.

4. Goals of the University

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).

Introduction to the Faculty of Earth and Ocean Science

5. The ocean is the last and least unexplored frontiers of the planet Earth. For this reason, Department of Oceanography and Hydrography of BMU 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:

i. Oceanography and Hydrography
ii. Mining
iii. Marine Fisheries and Aquaculture
iv. Marine Biology
v. Genetic Engineering and Biotechnology
vi. Environment Studies

Introduction to the Department of Oceanography and Hydrography

6. 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.

7. Introduction to the Programme

i. Name of the Programme: Bachelor of Science (B.Sc.) (Honours) in Oceanography

ii. Background of the Programme:

Bangladesh is the owner of 1,18,813 km^2 sea area in the northern Bay of Bengal. All these areas of Bay of Bengal offer potential living and nonliving resources for the

country. In order to ensure the contribution of these resources in the blue economy, Bangladesh need to produce skilled manpower and researcher on ocean science, ocean resources and ocean environment. The Bachelor of Science (Honours) in Oceanography is an Under Graduate degree program that deals with the study on different aspect of physical, chemical, biological, geological and atmospheric aspects of the world Ocean especially the Bay of Bengal. The 'Bachelor of Science (B.Sc.) 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. The course also provides scientific-technical training and the methodology necessary for oceanographic research during their research project at final year.

8. Vision of the Programme: Developing world-class undergraduate to penetrate the Oceanography and Hydrography professionals.

9. Mission of the Programme

- To provide quality education for producing qualified graduates in oceanography and hydrography to contribute to the various sectors of oceanography.
- Provide and equip students with knowledge, understanding, proficiencies, skills, competences, attitudes and values to qualify and prepare them for oceanographic and hydrographic sector as well as any managerial position in maritime domain and also to produce graduates who are qualified to pursue a professional career or advanced studies in a related field of specialization.
- To produce graduates who are qualified to pursue a professional career or advanced studies in a related field of specialization.
- Supporting and structuring industry attractive curriculum and state of the art teaching.

10. Outcome Based Education (OBE) and its importance:

Outcome based education (OBE) is student-centered instruction model that focuses on measuring student performance through outcomes. Outcomes include knowledge, skills and attitudes. Its focus remains on evaluation of outcomes of the program by stating the knowledge, skill and behavior a graduate is expected to attain upon completion of a program and after 4 – 5 years of graduation. It finds that the educational system does not rely solely on the conventional teaching methods. And it believes that the use of assessments, opportunities and classroom experiences should all provide necessary support for the students to achieve their goals. Some of the benefits of OBE are, as it focuses on outcomes, creates a clear expectation of what needs to be accomplished by the end of the course. Students will understand what is expected from them and teachers will know what they need to teach during the course. The second one is flexibility, with a clear sense of what needs to be accomplished, instructors will be able to structure their lessons around the student's needs. OBE does not specify a specific method of instruction, leaving teachers free to teach their students using any method. Apart from this, student involvement in the classroom is a key part of OBE. Students are expected to do their own learning, so that they gain a full understanding of the material. Increased student involvement allows students to feel responsible for their own learning, and they should learn more through this individual learning. Last but not the least, OBE is at the cutting edge of

curriculum development and an understanding of the expected learning outcomes can contribute to our appreciation and success of newer approaches to Genetic Engineering and Biotechnology related education.

11. Programme Outcomes: Programme outcomes are as follows

1) Demonstrate an interdisciplinary knowledge of coastal and marine systems.

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

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

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

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

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

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

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

12. Program Learning Outcomes (PLO):

After the successful completion of the Bachelor of Science (B.Sc.) in Oceanography programme, the students will be able to:

1) 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.
2) Describe the progressions of major earth science theories, including new analytic methods, sensors, and numerical methods in the field of oceanography.
3) 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.
4) Collect and manipulate oceanic, atmospheric, and geospatial data sets and rigorously analyze and interpret observational data, in situ experimental data, and model results.
5) Explain how living organisms capture and process energy; photosynthesis, metabolism, primary productivity in the ocean and ocean chemistry and processes of nutrient cycling.
6) Classify oceanic life, marine environment and systems of nomenclature and describe various marine communities; their types and composition.

7) Discuss the physical factors affecting marine life, succession and other changes in marine communities.
8) Evaluate the interaction between humans and the ocean.
9) Explain how physical and chemical factors in the ocean affect the climate in the past, present and future.
10) Interpret and critique professional scientific literature.

13. Graduate Profile (Generic Skills):

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

14. Duration of Course and Course Structure

14.1. Duration of the Programme

Bachelor of Science (B.Sc.) in Oceanography is a 4 years full time regular undergraduate programme under the Department of Oceanography and Hydrography. The programme is designed with theoretical courses a research project. Besides, the student has to perform fieldtrip/ study tour, lab work and seminar.

- Programme Duration: 04 years.
- Number of Semester: 08
- Semester Duration: 06 months.
- Number of Semester in Each Year: 02
- Total Number of Credit available: 150
- Minimum credit to be earned for degree requirements:150

14.2. Distribution of Weeks of Each 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
Total	**=**	**26 weeks**

15. Medium of Instruction and Examination

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

16. Eligibility to Appear at the Semester Final Examinations

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

a) A student must 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:

Attendance Percentage	Status	Notes
75% or above	Qualified (eligible)	The student will be allowed for the examinations.
60% – 74%	Non-Collegiate /Conditional	In this case, the student has to apply to Head of the Department for appearing in the examination. He may be allowed for seating in the exam only after clearance of accumulated payment that counted by the authority from different dues.
59% or below	Disqualified/ Ineligible	The student may not be permitted to sit for the examinations; however, all relevant rules and regulations outlined in the university's examination policy must still be followed.

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

17. Academic Grading System

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

18. Calculation of GPA and CGPA

Calculation procedure of GPA (Grade Point Average) and CGPA (Cumulative Grade Point Average) is as follows:

a) Grade Point Average (GPA) is the weighted average of the grade points obtained in all the courses passed/ completed by a student in a semester. 'F' grades will not be counted for GPA calculation. GPA of a Term will be calculated as follows:

$$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$$

where,

- n is the number of courses passed by the student;
- C_i is the number of credits assigned to a particular course i;
- And G_i is the grade point corresponding to the grade awarded for i-th course.

A numerical example: Suppose a student has passed five courses in a semester and obtained the following grades:

Course Code	Credit	Letter Grade	Grade Points
OCN 2101	3	A+	4.00
OCN 2102	3	C+	2.50
OCN 2103	3	D	2.00
OCN 2104	2	B	3.00
OCN 2105	2	B+	3.2

$$GPA = \frac{3(4.00) + 3(2.50) + 3(2.00) + 2(3.00) + 2(3.25)}{(3 + 3 + 3 + 2 + 2)} = 2.92$$

b) The Cumulative Grade Point Average (CGPA) gives the cumulative performance of the student from the first Term up to any other Term to which it refers and is computed by dividing the total grade points (©CiGi) accumulated up to the date by the total credit hours (©Ci).

$$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$$

A numerical example: Suppose a student has passed four semesters and obtained the following grades:

Semester	GPA	Credit
1st Year 1st Semester	4.0	17
1st Year 2nd Semester	3.0	22
2nd Year 1st Semester	3.5	18
2nd Year 2nd Semester	3.0	20

$$CGPA = \frac{4.00(17) + 3.00(22) + 3.50(18) + 3.00(20)}{(17 + 22 + 18 + 20)} = 3.36$$

Both GPA and CGPA will be rounded off to the second place of decimal for reporting**.**

i. To calculate CGPA, no **grades** from any source other than that of the prescribed credits will be considered.

ii. In the Academic Transcript/Grade sheet, only Letter Grade (LG), corresponding Grade Points (GP), Points Secured (PS) and finally GPA, CGPA, not the numerical marks, shall be shown.

19. Conduct of Courses

i. In a semester, teacher(s) should be assigned to plan and teach a particular course. The following guidelines shall be followed to conduct the 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 textbooks/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 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 project work shall be assigned, either individually or in groups on any issue pertaining to the course.

d) Several individual and group assignments, presentations, etc. shall be assigned to students as per the course requirements.

20. Performance Evaluations

20.1 Continuous Assessment.

20.1.1 Class Attendance

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%

20.1.2 Theory Courses.

A. Mark Distribution

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-term exam etc. Term Final Examination is conducted centrally by BMU. Term 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.	Term Paper/Assignment/Presentation	05%
d.	Class Tests/Quiz	10%
e.	Mid Term Examination (01 Exam)	15%
Total Marks for Continuous Assessment		**40%**
f.	Semester Final Examination	60%
	Total	**= 100%**

- For a theory course, the number of quizzes or class tests conducted shall be **n+1**, where **n** is the number of credit hours of that course. It means for 3 credits course, total 3+1=4 class test/quizzes will be taken.
- From the conducted quizzes/ class test, n number of test to be counted for assessment. It means for 3 credit course n=3 and total 3+1=4 class test be taken, but while evaluation best n number class test result (for 3 credit course it is 3) is to be averaged for evaluation.
- This allows one lower (or zero) quiz/test to be dropped, reducing the impact of an aberrant poor performance or absence.
- The combined weight of all considered quizzes/tests contributes to the **10%** portion of the course continuous assessment.

B. Mid-Term Examination

- A single Mid-Term Examination is part of the continuous assessment scheme.
- It carries 15 % of the total course marks.
- The Mid ensures that students are periodically assessed on course content before the end of the semester and provides a feedback checkpoint.

- Performance in the Mid may be used to gauge students' progress, help guide further teaching, and motivate students to stay engaged.

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).

20.1.3 Lab Courses:

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%**

20.1.4 Field Work:

The distribution of marks for field trip is given below:

a.	Attendance	10%
b.	Performance during Field work	20%
c.	Visit Report	40%
d.	Presentation	30%
	Total =	**100%**

20.2 Marks Distribution of the Thesis/ Project

Marks distribution of the thesis/ project is as follows:

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

21. Viva-Voce

a) A regular student shall appear at the viva-voce of the 1st/ 2nd/ 3rd/ 4th-year examination 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.

b) 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 15 days from the (date of preceding regular). Viva-voce of the respective examination and also before the publication of the respective examination. However, the candidates shall have to take permission from the Vice-Chancellor producing necessary documents. In

this case, s/he shall have to bear all expenses to conduct the viva-voce as fixed by the University Authorities.

c) If a student does not avail the above clause 21a & 21b, i.e. does not appear at the annual viva voce, s/he shall be declared to have failed in the respective examination.

22. The Requirements for Promotion to the Next Term

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/ term 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 that he/she does not have 'F' grades in more than two subjects including *backlog subjects* (if any).

23. Failed Student and Retaking a Course

It is expected that students will obtain a degree by clearing the entire offered courses of specified credit hours as per the syllabus within specified time period. Following guidelines will be followed for a failed student:

a) A student obtaining 'F' grade in a course/ subject may be allowed to reappear the examination of the 'F' grade subject/ course with the prior approval of Head of the Department on the recommendation of the course coordinator. Such approval shall be reported to the Academic Council (AC).
b) If a student gets 'F' grade in three or more subjects/ courses in a level (year/ session) of two semesters, he/ she will be required to repeat all the courses of that session **with the batch that immediately follows as an irregular candidate; failing which** *s/he* **shall be dropped out of the programme.**
c) If a student gets 'F' grade in not more than two subjects/ courses in a semester, then in order to pass in these failed subject(s)/ course(s), he/ she will be allowed to participate in re-examination of 'F' graded subject(s)/ course(s) with the next semester (as Retake subjects/ courses);
d) 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.
e) A student participating in the re-examination of 'F' grade subject(s)/ course(s) may be awarded a maximum letter grade B+ (grade point 3.25);
f) If a student fails in the re-examination of 'F' grade subject/ course, he/ she will pass to the next session if fulfils the criteria of section 37 (b). However, he must participate in the subsequent re-examination of 'F' grade subject/ course and pass as a backlog subject. Otherwise, he/she will be withdrawn from the program;
g) 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 subject to the approval of the Academic Council.

24. Time Limit

No student shall be permitted to continue as a Bachelor's Degree candidate beyond the end of the sixth academic year of his/her first admission into the university.

25. Credit Earned

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. All courses are compulsory.

26. Degree Requirements

For the bachelor's degree with Honours, a student shall require fulfilling the following conditions:

i. A student must complete all the courses within a maximum of six years;
ii. According to the syllabus of the program, the student has to pass the final examination of each course;
iii. A student must submit his/her research/ project report and present it before the designated panel after fulfilling the required conditions;
iv. A student must achieve a minimum of 2.2 CGPA in the programme.
v. Some programs may require completion of 'degree ++' courses as per individual program requirement.

27. Degree to be Awarded

A student who has secured a minimum CGPA of 2.2 after the eight semesters will be awarded a B.Sc. (Hons) in Oceanography.

28. Year of Degree Awarded

The results of a candidate for four-year bachelor's degree shall be awarded in the year in which s/he fulfils the requirements for the degree.

29. Improvement of Grades

a) 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 of maximum two subjects/ courses in an academic year.
b) If a student fails to improve his / her previous grade despite participating in the improvement exam, his/ her previous grade will remain valid.
c) 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.

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

30. Course Designation System

a) 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:
b) The first digit corresponds to the year/level in which the course is normally taken by the students.
c) The second digit corresponds to the semester/ term in which the course is normally taken by the students.
d) The last two digits denote various courses, where an odd number is used for theoretical courses and an even number for Laboratory/Practical courses.

31. Conduct of Research Project/ Group Project/ Survey Project/ Internship in Industry/ Industrial Attachment

Research Project/ Group Project/ Survey Project/ Internship in Industry/ Industrial Attachment will be conducted as per guidelines laid in the Academic Ordinance for Undergraduate Programmes. Any other issues relevant to conduct of research will be determined by the respective authority of the university.

32. Curriculum Structure

Bachelor of Science (B.Sc.) in Oceanography programme consists of the following categories of courses:

Category of the Course	No. of Courses	Credits	%
Core Courses (CC)	25	67	**44.67%**
Skill Development (SKD)	19	29	**19.33%**
Fundamental Courses (FC)	14	33	**22.00%**
Allied Courses (AC)	9	17	**11.33%**
Elective Courses (EC)	0	0	**0.00%**
Research Courses (RC)	2	6	**4.00%**
Total	**69**	**150**	**100%**

33. Semester Wise Distribution of the Courses

Distribution of the courses is given below:

1st Year 1st Semester				
Course Code	**Course Name**	**Credits**	**Category**	**Page**
OCN 1101	Introduction to Oceanography	3	FC	22
OCN 1103	Mathematics I	2	AC	25
OCN 1105	Physics I	2	AC	29
OCN 1106	Physics Lab	1.5	SKD	33
OCN 1107	Chemistry I	2	AC	36
OCN 1108	Chemistry Lab	1.5	SKD	39
OCN 1109	Communicative English	2	AC	43
OCN 1111	Marine Ecology	3	CC	46
OCN 1112	Marine Ecology Lab	1.5	SKD	50
	Total	**18.5**		
1st Year 2nd Semester				
Course Code	**Course Name**	**Credits**	**Category**	**Page**
OCN 1201	Physical Oceanography	3	CC	55
OCN 1202	Physical Oceanography Lab	1.5	SKD	59
OCN 1203	Biological Oceanography	3	CC	63
OCN 1204	Biological Oceanography Lab	1.5	SKD	68
OCN 1205	Mathematics II	2	AC	71
OCN 1207	Physics II	2	AC	74
OCN 1209	Chemistry II	2	AC	77
OCN 1211	Port and Shipping Management	2	AC	81
OCN 1212	Viva-voce	1.5	FC	85
OCN 1213	Field Work I: Field Methods in Oceanography	1.5	SKD	87
	Total	**20**		
2nd Year 1st Semester				
Course Code	**Course Name**	**Credits**	**Category**	**Page**
OCN 2101	River and Delta System	2	FC	91
OCN 2103	Geological Oceanography	3	CC	95
OCN 2104	Geological Oceanography Lab	1.5	SKD	100
OCN 2105	Statistics	3	CC	103
OCN 2107	Marine Renewable Energy	2	FC	107
OCN 2109	Chemical Oceanography	3	CC	112
OCN 2110	Chemical Oceanography Lab	1.5	SKD	117
OCN 2111	Meteorology	3	FC	120
	Total	**19**		
2nd Year 2nd Semester				
Course Code	**Course Name**	**Credits**	**Category**	**Page**
OCN 2201	Sedimentology and Stratigraphy	3	CC	125

OCN 2202	Sedimentology and Stratigraphy Lab	1.5	SKD	129
OCN 2203	Fisheries Oceanography	3	CC	132
OCN 2204	Fisheries Oceanography lab	1.5	SKD	136
OCN 2205	Marine Microbiology	3	CC	139
OCN 2206	Marine Microbiology Lab	1.5	SKD	143
OCN 2207	Foundations of Data Science	2	FC	147
OCN 2208	Foundations of Data Science Lab	1.5	SKD	151
OCN 2209	Viva-voce	1.5	FC	154
OCN 2210	Field Work II: Observational Techniques in Oceanography	1.5	SKD	157
	Total	**20**		
3rd Year 1st Semester				
Course Code	**Course Name**	**Credits**	**Category**	**Page**
OCN 3101	Ocean Optics	2	CC	164
OCN 3103	Computer Methods in Earth and Ocean Sciences	3	CC	168
OCN 3104	Computer Methods in Earth and Ocean Sciences	1.5	SKD	172
OCN 3105	Ocean Governance	3	CC	176
OCN 3107	Coastal Oceanography & Morphology	3	CC	182
OCN 3109	Geophysics	3	FC	186
OCN 3111	Acoustical Oceanography	2	CC	192
OCN 3113	Water Science & Resources Management	3	FC	196
	Total	**20.5**		
3rd Year 2nd Semester				
Course Code	**Course Name**	**Credits**	**Category**	**Page**
OCN 3201	Geophysical Fluid Dynamics	3	CC	202
OCN 3203	Hydrography	3	CC	206
OCN 3204	Hydrography Lab	1.5	SKD	209
OCN 3205	GIS and Remote Sensing	3	FC	212
OCN 3206	GIS and Remote Sensing Lab	1.5	SKD	221
OCN 3207	Research Methodology	2	RC	226
OCN 3209	Marine Biodiversity and Conservation	2	FC	230
OCN 3210	Viva-voce	1.5	FC	234
OCN 3211	Field Work III: Oceanographic Cruise Techniques	1.5	SKD	236
	Total	**19.0**		
4th Year 1st Semester				
Course Code	**Course Name**	**Credits**	**Category**	**Page**
OCN 4101	Ocean Modeling	2	CC	240
OCN 4102	Ocean Modeling Lab	1.5	SKD	243
OCN 4103	Paleontology & Paleoceanography	3	CC	246
OCN 4105	Coastal and Marine Pollution	3	CC	250
OCN 4107	Marine Biogeochemistry	3	FC	255

OCN 4109	Energy and Mineral Resources	3	FC	258
OCN 4111	Integrated Coastal Zone Management	3	CC	265
	Total	**18.5**		
4th Year 2nd Semester				
Course Code	**Course Name**	**Credits**	**Category**	**Page**
OCN 4201	Environmental Impact Assessment	2	CC	271
OCN 4203	Climate Change	3	AC	274
OCN 4205	Smart Technology	2	CC	279
OCN 4207	Research Project	4	RC	282
OCN 4208	Viva-voce	2	FC	283
OCN 4209	Field Work IV: Advanced Field Oceanography	1.5	SKD	285
	Total	**14.5**		
	Grand Total Credits	**150**		

Detail Syllabus First Semester
(Year-1, Semester-1)

Course Title: Introduction to Oceanography	
Course Code: OCN 1101	**Credit: 3.0**

PART A

1) Course Code: OCN 1101

2) Course Title: Introduction to Oceanography

3) Course Type: FC

4) Year and Semester: Year 1, Semester 1

5) Prerequisite (if any): N/A

6) Credits: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives

This foundation-level course introduces students to the multidisciplinary field of oceanography. It explores the history, scope, and branches of oceanography, the structure of ocean basins, seawater properties, and the interactions between the ocean and the atmosphere. Students are also introduced to maritime platforms, modern ocean observation technologies, and the societal relevance of ocean literacy.

Course Objectives:

- To introduce the fundamental branches and history of oceanography.
- To understand the geological, physical, and chemical nature of ocean basins and seawater.
- To explore the origin of Earth, oceans, and life, and marine productivity.
- To provide knowledge about maritime platforms, navigation, and ship safety.
- To examine the role of technology and literacy in understanding and protecting ocean resources.

10) Course Learning Outcomes (CLOs)

i. **CLO 1:** Define the scope, history, and main branches of oceanography.
ii. **CLO 2:** Describe the origin and evolution of Earth, oceans, marine life, and major features of the seafloor and coastlines.
iii. **CLO 3:** Explain key physical and chemical properties of seawater, climate interactions, and sediment characteristics.
iv. **CLO 4:** Identify maritime platforms and observation technologies and evaluate human impacts and the importance of ocean literacy.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	**3**	2	1	1	1	1	1	1	1
CLO 2	**3**	**3**	**3**	2	1	1	1	1	1	1
CLO 3	2	**3**	**3**	**3**	1	1	1	1	1	1
CLO 4	2	**3**	**3**	**3**	**3**	2	1	**3**	1	1

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Definition, branches, approaches, and scope of oceanography	Week 1	Lecture, discussion, mind map activity	Quiz	CLO 1
2	History of oceanography: early voyages to satellite era	Week 2	Timeline activity, multimedia clips	Class Test	CLO 1
3	Origin of Earth, atmosphere, and oceans	Week 3	Concept illustration, simulation video	Short quiz	CLO 2
4	Origin, development, and characteristics of life in the ocean; marine productivity	Week 4	Lecture, trophic pyramid drawing	Assignment	CLO 2
5	Characteristics of major oceans; major features of ocean basins	Week 5	Map-based activity, ocean atlases	Group activity	CLO 2
6	Coastlines and coastal processes	Week 6	Case study discussion, diagrams	Assignment	CLO 2
7	▪ Mid-Term Examination ▪ Types, origin of ocean sediments.	Week 7	—	▪ Mid-term Exam (15 marks) ▪ Diagram analysis	— CLO 3
8	Classification of ocean sediments	Week 8	Diagram analysis, sample	Quiz	CLO 3

			photo interpretation		
9	Physical and chemical characteristics of seawater	Week 9	Concept charts, role-play	Class Test	CLO 3
10	Ocean-climate interaction (currents, El Niño, feedbacks)	Week 10	Diagrams, climate model illustrations	Assignment	CLO 3
11	Institutions, journals, and education on oceanography worldwide	Week 11	Web search, interactive presentation	Quiz	CLO 1
12	Maritime platforms: types of ships, parts, navigation instruments	Week 12	Infographics, image labeling, video walkthrough	Class Test	CLO 4
13	Ocean observation tools (satellites, Argo floats, drifters); real-time data	Week 13	Short videos, group discussions	Assignment	CLO 4
14	Human impacts on the ocean; marine pollution, climate change, ocean literacy	Week 14	Group debate, UN Decade overview	Viva & Final Assignment (40 marks)	CLO 4

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5		3	10
Understand		1	5		3	10
Apply	5				2	10
Analyze		1		2	3	15
Evaluate		1		2	2	10
Create		1		1	2	5

PART D

Textbooks:

- Garrison, T. (2021). *Oceanography: An Invitation to Marine Science*
- Thurman, H. V. (2013). *Essentials of Oceanography*
- Sverdrup, K. A., & Armbrust, E. V. (2008). *An Introduction to the World's Oceans*

Course Title: Mathematics I	
Course Code: OCN 1103	Credit: 2.0

PART A

1) Course Code: OCN 1103

2) Course Title: Mathematics I

3) Course Type: AC

4) Year and Semester: Year 1, Semester 1

5) Prerequisite (if any): Fundamentals of HSC level.

6) Credit: 2

7) Contact Hours: 28

8) Total Marks: 100

9) Course Summary and Objectives:

This course provides a comprehensive foundation in calculus and vector analysis. It begins with the fundamentals of functions, limits, continuity, and differentiation, including advanced topics like successive differentiation, Rolle's and Mean Value Theorems, and series expansions (Maclaurin and Taylor), function analysis, maxima and minima, L'Hôpital's Rule, partial differentiation. The course then explores differential and integral calculus and integration techniques. Applications of integration include areas, volumes, arc lengths, surface areas, work, fluid mechanics, and special functions. The final section introduces vector calculus, focusing on scalar and vector fields, gradient, divergence, curl, and the major theorems—Green's, Stokes', and Divergence—essential for physical and engineering applications.

Course objectives include –

- To understand the basics of calculus, including limits, derivatives, and series.
- To understand how to analyze and solve problems using differentiation and integration.
- To understand how calculus can be applied to real-world problems like areas, volumes, work, and fluid mechanics.
- To understand vector calculus concepts and important theorems for physical applications.
- To understand how to use mathematical tools to interpret and analyze physical phenomena.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Understand and apply the fundamental concepts of calculus, including limits, derivatives, and series expansions.
ii. **CLO 2:** Analyze functions and solve problems using differentiation and integration techniques.
iii. **CLO 3:** Apply calculus concepts to real-world problems, including areas, volumes, work, and fluid mechanics.
iv. **CLO 4:** Understand vector calculus concepts and apply key theorems (Green's, Stokes', Divergence) to physical and engineering problems.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	**3**	2	2	1	1	1	1	1	2
CLO 2	**3**	2	**3**	**3**	2	1	1	1	1	2
CLO 3	**3**	2	2	**3**	2	1	1	**3**	**3**	2
CLO 4	**3**	2	**3**	**3**	2	1	1	1	**3**	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Fundamentals of geometry / trigonometry (coordinates, angle, triangular solution, distance, slope, area and volume of cylinder and cone), Functions, Limits, Continuity	Week-1	Lecture, Discussion	Assignment	CLO1
2	Differentiability, rate of change and Rules of Differentiation, Successive Differentiation and Leibniz's Theorem	Week-2	Lecture, Discussion	Class performance and interactions	CLO 1, CLO2,
3	Rolle's Theorem and Mean Value Theorem, Maclaurin and Taylor Series	Week-3	Lecture, Group Discussion	Class Test/Quiz-1	CLO 1, CLO 2
4	Analysis of Functions: Increasing/Decreasing Behavior, Concavity	Week-4	Interactive discussion, white board illustration	Presentation, interactions	CLO 2
5	Absolute and Relative Maxima and Minima, Evaluation of Indeterminate forms by L'Hôpital's rule	Week-5	Power point presentation, white board illustration	Class Test/Quiz-2	CLO 2

6	Partial Differentiation and Euler's Theorem	Week-6	White board illustration, discussion on assignments	Oral viva, interactions	CLO 2, CLO 4
7	▪ **Mid-Term Examination** ▪ The Indefinite Integral	Week-7	– Power point presentation		– CLO 2
8	Integration by the Method of Substitutions, Integration by parts; Trigonometric Integrals	Week-8	Power point presentation, white board illustration, discussions on mid-term scripts	Class Task	CLO 2
9	Integrating Rational Functions by Partial Fractions, Standard integrals, Integration by the Method of successive reduction	Week-9	Lecture, Discussion	Class Test/Quiz-3	CLO 2
10	The Fundamental Theorem of Calculus, Definite Integrals and its properties	Week-10	Lecture, independent reading	Group assignment	CLO 2
11	Area Between Curves, Volumes, Arc Length	Week-11	Power point presentation, white board illustration, interactive Q&A	Brain-storming and performance	CLO 3
12	Improper Integrals and Special Functions (Beta & Gamma Functions)	Week-12	Power point presentation, white board illustration	Interactions	CLO 3
13	Scalar and Vector Fields, Gradient, Divergence, and Curl	Week-13	Power point presentation, white board illustration, independent reading	Class Task	CLO 4
14	Vector Differentiation and Integration, Theorems of Vector Calculus: Divergence Theorem, Stokes' Theorem, Green's Theorem	Week-14, 15	Power point presentation, white board illustration	Brain-storming and performance	CLO 4

PART C

13) Assessment and Evaluation

Bloom's Category	Continuous Internal Evaluation					Semester Final Examination
	Attend. (05)	Class Performance (05)	Class Tests (10)	Assign. (05)	Mid Term (15)	Final (60)
Remember		1	5		3	10
Understand		1	5		3	10
Apply	5				2	10
Analyze		1		2	3	15
Evaluate		1		2	2	10
Create		1		1	2	5

PART D

14) Textbook:

Calculus, by Howard Anton, IRL Bivens, Stephen Davis. Wiley (10^{th} edition), ISBN: 1118137922.

15) Reference Books:

1. Differential Calculus, by B. C Das, B. N Mukherjee, U. N. Dhur& Sons Pvt. Ltd (55^{th} edition), ISBN: 9380673876.
2. Integral Calculus, by B. C Das, B. N Mukherjee. (58^{th} edition)
3. A Text Book On Co-ordinate Geometry with Vector Analysis, by A. F. M. Abdur Rahman and P. K. Bhattacharjee. (11^{th} edition)
4. Calculus by Swokowski 6th Edition
5. Differential Calculus 5th Edition - DR MD Abdul Matin
6. Integral Calculus and Differential Equation (5th Edition) by Dr. Md. Abdul Matin

Course Title: Physics I	
Course Code: OCN 1105	Credit: 2.0

PART A

1) **Course Code:** OCN 1105
2) **Course Title:** Physics I
3) **Course Type:** AC
4) **Year and Semester:** Year 1, Semester 1
5) **Prerequisite (if any):** Fundamentals of HSC level.
6) **Credit:** 2
7) **Contact Hours:** 28
8) **Total Marks:** 100
9) **Course Summary and Objectives:**
   This course introduces students to the fundamental laws and principles of classical mechanics, gravitation, oscillations, wave dynamics, electricity, and magnetism. The curriculum emphasizes their applications in the context of oceanographic phenomena, such as satellite-based observations, coastal wave behavior, and electromagnetic interactions in marine environments.

   Course objectives include –
   - To understand motion and Newtonian mechanics and apply them to physical systems.
   - To explore principles of energy conservation and momentum.
   - To analyze gravitational interactions and planetary motion, with marine applications.
   - To study oscillations and wave properties, including ocean wave dynamics.
   - To introduce basic electricity and magnetism concepts relevant to physical systems.

10) **Course Learning Outcomes (CLOs):**

   i. **CLO 1:** Apply Newton's laws, momentum conservation, and energy concepts to mechanical systems.
   ii. **CLO 2:** Understand and analyze gravitational interactions, satellite motion, and planetary orbits.
   iii. **CLO 3:** Interpret oscillatory motion and surface wave behavior in oceanographic contexts.
   iv. **CLO 4:** Explain fundamental electrical and magnetic field interactions and their relevance to marine systems.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	**3**	**3**	2	2	2	1	1	1	2
CLO 2	**3**	**3**	**3**	**3**	2	2	1	1	1	2
CLO 3	2	**3**	**3**	2	**3**	2	1	**3**	1	2
CLO 4	2	**3**	**3**	**3**	**3**	**3**	1	2	1	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1)	Motion in one dimension: position–time and velocity–time graphs, acceleration	Week 1	Lecture, graph analysis	Quiz, in-class problems	CLO 1
2)	Newton's laws of motion, friction, free body diagrams	Week 2	Concept mapping, board work, demos	Assignment, problem solving	CLO 1
3)	Work–Energy Theorem, conservative forces, potential energy, conservation of energy	Week 3	Whiteboard illustration, conceptual questions	Quiz, class interaction	CLO 1
4)	Momentum, collisions, and conservation laws	Week 4	Derivation, group work	Class Test	CLO 1
5)	Law of Universal Gravitation, gravitational field, gravitational potential	Week 5	Visual explanation, derivation with graphs	Quiz	CLO 2
6)	Planetary motion, Kepler's laws, satellite motion	Week 6	Animation-based learning, NASA satellite examples	Assignment	CLO 2
7)	▪ Mid-Term Examination ▪ Escape velocity, marine satellite applications	Week 7	— Animation-based learning	Mid-term Exam	— CLO 2
8)	Simple harmonic motion: spring-mass,	Week 8	Whiteboard derivation, group calculation	Quiz	CLO 3

	pendulums, energy conservation				
9)	Damping: under, over, critical; forced oscillations and resonance	Week 9	PPT + discussion, real-world examples	Class Test	CLO 3
10)	Ocean waves: parameters, classification, wind waves and swells	Week 10	Ocean animations, conceptual linkage	Assignment	CLO 3
11)	Wave theories: small amplitude theory, refraction, diffraction, reflection, Rossby & Kelvin waves	Week 11	Board derivations, video walkthroughs	Quiz	CLO 3
12)	Waves and coastal morphology: wave energy flux, breaking, run-up	Week 12	Wave simulation videos, case studies	Assignment	CLO 3
13)	Basics of electricity: electric charge, field, dipole, Gauss's law	Week 13	Board work, conceptual discussion	Quiz	CLO 4
14)	Magnetism: induction, Faraday's law, Lenz's law, Ampere's law	Week 14	Interactive board lecture, marine EM case study	Viva, Final Assignment	CLO 4

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5		3	10
Understand		1	5		3	10
Apply	5				2	10
Analyze		1		2	3	15
Evaluate		1		2	2	10
Create		1		1	2	5

PART D

14) Textbook:

- Young, H. D., & Freedman, R. A. (2019). *University Physics with Modern Physics* (15th Edition). Pearson. ISBN: 9780135159552

15) Reference Books:

1. Serway, R. A., & Jewett, J. W. (2013). *Physics for Scientists and Engineers* (9th Edition). Cengage Learning.
2. Halliday, D., Resnick, R., & Walker, J. (2013). *Fundamentals of Physics* (10th Edition). Wiley.
3. Tipler, P. A., & Mosca, G. (2007). *Physics for Scientists and Engineers* (6th Edition). W. H. Freeman.
4. Feynman, R. P., Leighton, R. B., & Sands, M. (2011). *The Feynman Lectures on Physics* (Vol. I). Basic Books.
5. Desiraju, G. R. (Ed.). (2001). *Essentials of Physics: Mechanics, Waves, and Thermodynamics*. Universities Press India.

Course Title: Physics Lab	
Course Code: OCN 1106	**Credit: 1.5**

1) Course Code: OCN 1106

2) Course Title: Physics Lab

3) Course Type: SKD`

4) Year and Semester: Year 1, Semester 1

5) Prerequisite (if any): Fundamentals of HSC level.

6) Credit: 1.5

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This laboratory course provides hands-on experience in fundamental experiments related to electricity, heat, mechanics, waves, and sound. It is designed to reinforce theoretical principles covered in Physics I, while also building experimental, measurement, error analysis, and report writing skills. Special emphasis is placed on scientific reasoning, procedural accuracy, and physical interpretation of data.

Course objectives include –

- To apply experimental techniques to verify physical laws and principles.
- To develop skill in using scientific instruments accurately and safely.
- To understand the concepts of resistance, frequency, specific heat, thermal conductivity, etc.
- To build skills in data collection, error analysis, and effective scientific reporting.

10) Course Learning Outcomes (CLOs):

i. **CLO 1:** Set up and perform basic physics experiments using standard laboratory instruments.

ii. **CLO 2:** Record, interpret, and analyze experimental data with appropriate error estimates.

iii. **CLO 3:** Apply theoretical concepts from Physics I to practical experiments involving mechanics, heat, waves, and electricity.

iv. **CLO 4:** Demonstrate scientific communication and lab safety skills through accurate reporting and presentations.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	**3**	2	1	1	2	1	1	1	1
CLO 2	**3**	**3**	**3**	2	**3**	2	1	1	1	2
CLO 3	**3**	**3**	**3**	**3**	2	2	1	**3**	1	2
CLO 4	2	**3**	2	1	2	**3**	1	**3**	1	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Lab Experiments	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1)	Specific resistance of wire (meter bridge)	Week 1	Lab demo, individual setup	Observation, viva	CLO 1, CLO 2
2)	Resistance of galvanometer (half deflection method)	Week 2	Step-by-step instruction, practical trials	Assignment, class interaction	CLO 1, CLO 2
3)	Fill factor of photovoltaic cell	Week 3	Group work, demonstration	Quiz, interpretation	CLO 1, CLO 3
4)	Specific heat of a liquid (cooling method)	Week 4	Lab note-taking, real-time measurement	Report submission	CLO 2, CLO 3
5)	Thermal conductivity by Lees and Chorlton's method	Week 5	Diagram-based instruction	Observation, viva	CLO 1, CLO 2
6)	Frequency of tuning fork (Melde's apparatus)	Week 6	Physical demonstration, discussion	Assignment	CLO 1, CLO 3
7)	Class Test	Week 7	—	Class Test (10 marks)	—
8)	Speed of sound using acoustic transducer	Week 8	Oscilloscope use, trial runs	Performance-based assessment	CLO 2, CLO 3
9)	Acceleration due to gravity (compound pendulum)	Week 9	Pendulum setup, plotting graphs	Viva, error analysis	CLO 1, CLO 2
10)	Spring constant and rigidity modulus	Week 10	Supervised experiment and plotting	Graph and calculations	CLO 3
11)	Archimedes' principle (buoyant	Week 11	Conceptual demo, explanation	Final Report	CLO 1, CLO 3, CLO 4

	up-draught vs. immersion depth)				
12)	Experiment Completion and Practice	Week 12	Guided revision	Checklist, feedback	All CLOs
13)	Report Writing and Submission	Week 13	Lab report preparation	Report Grading (10 marks)	CLO 4
14)	Final Viva	Week 14	Individual oral exam	Viva Voce (10 marks)	CLO 4

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**				**Semester Final Examination**
	Attend. (10)	**Class Performance (10)**	**Viva/presentation (20)**	**Assign./Lab report (20)**	**Final (40)**
Remember		02	05		05
Understand		02	10	3	05
Apply		02		2	05
Analyze		02		05	10
Evaluate		02	05	10	05
Create					10

PART D

14) Textbook:

1. Practical Physics, by Dr. Giasuddin Ahmad.

Course Title: Chemistry I	
Course Code: OCN-1107	Credit: 2.0

PART A

1) Course Code: OCN 1107

2) Course Title: Chemistry I

3) Course Type: AC

4) Year and Semester: Year 1, Semester 1

5) Prerequisite (if any): Fundamentals of HSC level.

6) Credit: 2

7) Contact Hours: 28

8) Total Marks: 100

9) Course Summary and Objectives:

A detailed study of basic chemistry including properties of matter, chemical reactions, gas or states of matter and acid and bases to develop basic knowledge about the structure, bonding and properties of matter.
Course objectives include –

i. To understand the need of Chemistry in daily life and to help students to solve analytical problems with a molecular perspective
ii. To develop fundamentals for future courses as Chemical Oceanography, Marine Geochemistry etc.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Explain the structure and understand the properties of matter
ii. **CLO 2:** Explain the bonding within atoms of a molecule and understand stoichiometry of reactions
iii. **CLO 3:** Develop basic foundation for understanding properties and analysis of seawater.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	2	2	2	2	2	2	1	1	1	2
CLO 2	2	2	**3**	2	2	2	1	1	1	2
CLO 3	2	2	**3**	**3**	**3**	**3**	1	**3**	2	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Structure of Atom	Week-1 Week-2	Lecture, Discussion	Class Test/Quiz-1	CLO 1
2	Periodic Table	Week-3	Lecture, Discussion, Presentation	Class Test/Quiz-1	CLO 1
3	Structure and Bonding	Week-4 Week-5	Lecture, Group Discussion	Class Test/Quiz-2	CLO 1, CLO 2
4	Organic Chemistry	Week-6	Interactive discussion, white board illustration	Class Test/Quiz-2	CLO 2, CLO 3
5	▪ Mid-Term Examination ▪ Organic Chemistry (Continued)	Week-7	— Interactive discussion, white board illustration		— CLO 2, CLO 3
6	Gas	Week-8 Week-9	Power point presentation, white board illustration	Assignment, Presentation, interactions, Oral viva, interactions	CLO 1, CLO 2, CLO 3
7	Phase Equilibrium	Week-10 Week-11	Power point presentation, white board illustration, discussion on assignments	Class Test/Quiz-3	CLO 1, CLO 2, CLO 3
8	Acids and Bases	Week-12 Week-13	Power point presentation, white board illustration	Class Test/Quiz-3	CLO 1, CLO 2, CLO 3
9	Revision class	Week-14	Power point presentation, white board illustration	Group discussion for problem solving of all chapters	CLO 1, CLO 2, CLO 3

PART C

13) Assessment and Evaluation

Bloom's Category	Continuous Internal Evaluation					Semester Final Examination
	Attend. (05)	Class Performance (05)	Class Tests (10)	Assign. (05)	Mid Term (15)	Final (60)
Remember		1	5		3	10
Understand		1	5		3	10
Apply	5				2	10
Analyze		1		2	3	15
Evaluate		1		2	2	10
Create		1		1	2	5

PART D

14) Textbook:

1. Introduction to Modern Inorganic Chemistry, by S.Z. Haider.
2. General Chemistry, by Ebbing & Gammon.
3. Principles of Physical Chemistry, by MM Haque & Molla.
4. Organic Chemistry, by Morrison & Boyd.
5. Essentials of Physical Chemistry, by Bahl & Tuli.

15) Reference Books:

1. Modern Inorganic Chemistry, R. D Madan, S Chand & Co, 1987
2. Selected Topics in Inorganic Chemistry, R. D. Madan, G D Tuli, Wahid U Malik, S Chand & Co, 2010.

Course Title: Chemistry Lab	
Course Code: OCN-1108	Credit: 1.5

PART A

1) Course Code: OCN 1108

2) Course Title: Chemistry Lab

3) Course Type: SKD

4) Year and Semester: Year 1, Semester 1

5) Prerequisite (if any): Fundamentals of HSC level

6) Credit: 1.5

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

A detailed study of qualitative and quantitative analysis was studied to develop basic knowledge about the proper interpretation of experimental results. Course objectives include –

- To develop confidence of the students to perform qualitative and quantitative analysis with an understanding of principles and proper interpretation of experimental results.
- To introduce students with contemporary instrumentation used in analytical chemistry.

10) Course Learning Outcomes (CLO)

i. **CLO 1:** To develop idea about the qualitative and quantitative analysis of substances
ii. **CLO 2:** To get acquainted with different experimental methods and instrumentation
iii. **CLO 3:** To enhance knowledge on data interpretation and analysis

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	2	2	2	2	2	2	1	1	1	2
CLO 2	2	2	**3**	2	2	2	1	1	1	2
CLO 3	2	2	**3**	**3**	**3**	**3**	1	**3**	2	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Purification of commercial sodium chloride, NaCl, by re-crystallization and salting out process.	Week-1	Lecture, Discussion Experimental work	Report writing, quiz	CLO 1, CLO 2, CLO 3
2	Preparation of Ferrous Ammonium Sulphate (Mohr's salt), $FeSO_4.(NH_4)_2SO_4.6H_2O$.	Week-2	Lecture, Discussion, Experimental work	Report writing, quiz	CLO 1, CLO 2, CLO 3
3	Qualitative analysis of few selected cations and anions from mixture of salts/from supplied solutions.	Week-3	Lecture, Discussion, Experimental work	Report writing, quiz	CLO 1, CLO 2, CLO 3
4	Preparation of a primary standard solution of oxalic acid and standardization of a supplied NaOH solution.	Week-4	Lecture, Discussion, Experimental work	Report writing, quiz	CLO 1, CLO 2, CLO 3
5	Preparation of a primary standard solution of Na_2CO_3 and standardization of a supplied HCl solution	Week-5	Lecture, Discussion, Experimental work	Report writing, quiz	CLO 1, CLO 2, CLO 3
6	Determination of the amount of Fe(II) and Fe(III) in a given sample using a standard dichromate solution.	Week-6	Lecture, Discussion, Experimental work	Report writing, quiz	CLO 1, CLO 2, CLO 3
7	Standardization of a sodium thiosulphate solution using a standard dichromate solution and hence determination of the amount of copper (II) in a supplied solution with the standard thiosulphate solution	Week-7	Lecture, Discussion, Experimental work	Report writing, quiz	CLO 1, CLO 2, CLO 3
8	Determination of hardness of the supplied water sample by	Week-8	Lecture, Discussion,	Report writing, quiz	CLO 1, CLO 2, CLO 3

	Complexometric Method.		Experimental work		
9	Elemental (Nitrogen, Sulphur and Halogen) analysis and melting point determination of some selected organic compounds.	Week-9	Lecture, Discussion, Experimental work	Report writing, quiz	CLO 1, CLO 3
10	Identification of few functional groups of some selected organic compounds.	Week-10	Lecture, Discussion, Experimental work	Report writing, quiz	CLO 1, CLO 3
11	Determination of the pH-neutralization curve of a strong acid by a strong base.	Week-11	Lecture, Discussion, Experimental work	Report writing, quiz	CLO 1, CLO 3
12	Determination of the dissociation constant of ethanoic acid by investigating its conductance behavior at different concentrations	Week-12	Lecture, Discussion, Experimental work	Report writing, quiz	CLO 1, CLO 3
13	Determination of the enthalpy change for the thermal decomposition of $NaHCO_3$ into Na_2CO_3	Week-13	Lecture, Discussion, Experimental work	Report writing, quiz	CLO 1, CLO 3
14	**Oral Viva and Class test**	Week-14			

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**				**Semester Final Examination**
	Attend. (10)	**Class Performance (10)**	**Viva/presentation (20)**	**Assign./Lab report (20)**	**Final (40)**
Remember		02	05		05
Understand		02	10	3	05
Apply		02		2	05
Analyze		02		05	10
Evaluate		02	05	10	05
Create					10

PART D

16) Textbook:

1. A Textbook of Macro and Semimicro Qualitative Inorganic Analysis, by A. I. Vogel; Fourth Edition.
2. Vogel's Textbook of Quantitative Inorganic Analysis, Revised by Bassett & Jeffery, John Wiley & Sons Inc (Fourth Edition).
3. A Handbook of Organic Analysis, by H. T. Clarke; Fifth Edition.

Course Title: Communicative English	
Course Code: OCN 1109	Credit: 3.0

PART A

1) **Course Code:** OCN 1109
2) **Course Title:** Communicative English
3) **Course Type:** AC
4) **Year and Semester:** Year 1, Semester 1
5) **Prerequisite (if any):** Good knowledge on English Grammer.
6) **Credit:** 3
7) **Contact Hours:** 42 hours
8) **Total Marks:** 100
9) **Course Summary and Objectives**

This course focuses on the fundamental aspects of English communication, enhancing students' reading, writing, speaking, and listening skills through integrated and interactive learning. The course combines grammar accuracy, paragraph and essay writing, reading strategies, and oral fluency with real-world applications in academic and professional life.

Course Objectives

- To improve academic writing in English.
- To develop reading comprehension and vocabulary skills.
- To enhance listening comprehension.
- To improve grammatical accuracy.
- To build confidence and fluency in spoken English.

10) Course Learning Outcomes (CLO):

i. CLO1: Apply correct grammar structures in writing and speech.
ii. CLO2: Use reading strategies to comprehend, interpret, and summarize various texts.
iii. CLO3: Write structured and coherent paragraphs, essays, and formal documents.
iv. CLO4: Demonstrate oral fluency and appropriate spoken expressions in structured and spontaneous situations.
v. CLO5: Listen actively and respond accurately to spoken English in various contexts.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO1	**3**	**3**	2	1	1	1	1	1	1	2
CLO2	2	**3**	**3**	2	1	1	1	1	1	2

CLO3	2	2	**3**	**3**	1	1	1	1	1	2
CLO4	2	2	2	**3**	1	1	1	**3**	1	2
CLO5	2	**3**	2	2	1	1	1	**3**	1	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Week	Course Topics / Subtopics	Teaching–Strategies	Assessment Methods	Aligned CLOs
1	Grammar: verb forms, tenses, articles	Grammar drills, fill-in-the-blanks	Quiz	CLO 1
2	Voice, prepositions, modals, subject–verb agreement, narration	Sentence construction, pair exercises	Class Test	CLO 1
3	Transformation, conditionals, tag questions, error corrections	Correction tasks, active recall	Assignment	CLO 1
4	Reading strategies: skimming, scanning, predicting, guessing	Reading excerpts, prediction games	Quiz	CLO 2
5	Reading comprehension and summarization	Paired reading, summary writing	Assignment	CLO 2
6	Vocabulary development through reading texts	Word-bank creation, reading logs	Short Test	CLO 2
7	**Mid-Term Examination** Vocabulary development	— Reading logs	— Classroom Presentation	CLO 2
8	Writing strategies: brainstorming, narrowing focus	Mind mapping, guided writing	In-class writing task	CLO 3
9	Paragraph and essay structure: narrative, argumentative, cause-effect	Writing samples, peer review	Assignment	CLO 3
10	Formal writing: letters, emails, memos, notices, reports	Format demonstration, group feedback	Quiz	CLO 3
11	Spoken English: daily situations, guided dialogues	Pair speaking tasks, role-play	Oral Assessment	CLO 4
12	Presentations, impromptu speech, IPA pronunciation symbols	Presentation practice, pronunciation drills	Presentation	CLO 4
13	Listening for main ideas, specific information, and instructions	Audio clips, listening tasks	Listening Quiz	CLO 5

14	Listening: news, songs, video clips; note-taking and response	Multimedia response worksheet	Listening Test	CLO 5

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5		3	10
Understand		1	5		3	10
Apply	5				2	10
Analyze		1		2	3	15
Evaluate		1		2	2	10
Create		1		1	2	5

PART D

Reference books:

1. Headway (Upper Intermediate), by Liz and John Soars, Oxford University Press, ISBN: 0194335593.
2. English Grammar & Composition, by Wren and Martin, S. Chand & Co. Ltd, ISBN: 8121900093.
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.

Course Title: Marine Ecology	
Course Code: OCN 1111	**Credit: 3.0**

PART A

1) Course Code: OCN 1111

2) Course Title: Marine Ecology

3) Course Type: CC

4) Year and Semester: Year 1, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course is designed to get knowledge of ecology. The coastal and marine environment has ecological characteristics that vary throughout the world. So, it is important to study ecology in oceanography.
Course objectives include –

- To learn about various coastal and oceanic ecosystems.
- To understand the interaction between the biotic and abiotic components of the ecosystem.
- To explore how environmental variables affect biological communities and ecological interactions.
- To know about different ecological parameters.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Recognize various coastal and marine ecosystems at global, regional and local level.
ii. **CLO 2:** Acquire a basic knowledge of interaction within various ecosystem components.
iii. **CLO 3:** Learn ecological and evolutionary adaptation of various species to a particular ecosystem.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / **CLO**	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	2	2	2	2	**3**	**3**	**3**	2	2	2
CLO 2	2	2	**3**	2	**3**	**3**	2	2	2	2
CLO 3	2	2	2	2	**3**	**3**	**3**	**3**	2	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Definition, scope and type of ecology and marine ecology	Week-1	Lecture, Discussion	Class performance and interactions	CLO 1
2	Marine environment	Week-2	Lecture, Discussion, Video Presentation	Assignment	CLO 1, CLO 2
3	Major ecological divisions of marine habitat.	Week-3	Lecture, Group Discussion	Class Test/Quiz-1	CLO 1, CLO 2
4	Comparative study of the flora and	Week-4	Interactive discussion, white board illustration	Presentation, interactions	CLO 1, CLO 2
5	Characteristics of sandy ecosystem	Week-5	Power point presentation, white board illustration	Assignment	CLO 2, CLO 3
6	Characteristics of muddy ecosystem	Week-6	Power point presentation, white board illustration, discussion on assignments	Oral viva, interactions	CLO 2, CLO 3
7	**Mid-Term Examination** Characteristics of rocky ecosystem	Week-7	— Power point presentation, white board illustration, discussion on assignments	— Presentation, interactions	CLO 2, CLO 3
8	Factors controlling the adaptation and distribution of ecological beings.	Week-8	Power point presentation, white board illustration, discussions on mid-term scripts	Presentation, interactions	CLO 2, CLO 4

9	Food chain, food webs and ecological niche	Week-9	Lecture, Discussion	Class Test/Quiz-2	CLO 1
10	Invertebrate Paleontology (Introduction, scope, distribution, and implications)	Week-10	Lecture, independent reading	Group assignment	CLO 1, CLO 3
11	Ecology of the Bay of Bengal	Week-11	Power point presentation, white board illustration, interactive Q&A	Brain-storming and performance	CLO 3
12	Ecology of the major estuaries	Week-12	Power point presentation, white board illustration	Class Test/Quiz-3	CLO 1, CLO 3
13	Geographical position and comparative study of the three major	Week-13	Power point presentation, white board illustration, independent reading	Assignment	CLO 1, CLO 3
14	Concepts of Biodiversity: Definition, types, patterns, factors causing loss of biodiversity.	Week-14	Power point presentation, white board illustration	Group Presentation	CLO 3

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5		3	10
Understand		1	5		3	10
Apply	5				2	10
Analyze		1		2	3	15
Evaluate		1		2	2	10
Create		1		1	2	5

PART D

16) Textbook:

1. Elements of Marine Ecology, by R. V. Tait, F. A. Dipper, Butterworth-Heinemann (4th edition, 1998).
2. Fundamental of Ecology, by E. Odum ,W. B. Gray, Cengage Learning (2004).

17) Reference Books:

1. An Introduction to Marine Science, by P. S. Meadows and J. I. Campbell, Springer.
2. The Oceans: Their Physics, Chemistry, and General Biology, by H. U. Sverdrup, M. W. Johnson, R. H. Fleming, Prentice Hall (1942).

Course Title: Marine Ecology Lab	
Course Code: OCN 1112	Credit: 1.5

PART A

1) Course Code: OCN 1112

2) Course Title: Marine Ecology Lab

3) Course Type: SKD

4) Year and Semester: Year 1, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 1.5

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course provides practical experience to understand different aspects of coastal and marine ecology by observation and recording information.

Course objectives include –

- To learn about the analysis procedure of ecological data.
- To do quantitative study and biodiversity determination or organisms.
- To determine different ecological parameters.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Understand the diversity of coastal and marine ecosystems.

ii. **CLO 2:** Determine biodiversity and zonation of the sea.

iii. **CLO 3:** Determine various ecological parameters.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	2	2	2	**3**	2	**3**	2	2	2	2
CLO 2	2	2	**3**	**3**	2	**3**	2	2	2	2
CLO 3	2	2	2	2	**3**	**3**	2	2	2	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Introduction and scope	Week-1	Lecture, Discussion	Class performance and interactions	CLO 1
2	Preparation of Model showing zonation of the sea.	Week-2	Lecture, Discussion, Video Presentation	Assignment	CLO 1, CLO 2
3	Quantitative study and biodiversity determination of marine organisms in the open water	Week-3	Lecture, Group Discussion	Class Test/Quiz-1	CLO 1, CLO 2
4	Quantitative study and biodiversity determination of marine organisms in the coastal water and floor of the sea	Week-4	Interactive discussion, white board illustration	Presentation, interactions	CLO 1, CLO 2
5	Laboratory practices in determination of various ecological parameters (Physical parameters).	Week-5	Power point presentation, white board illustration	Assignment	CLO 2, CLO 3
6	Laboratory practices in determination of various ecological parameters (Bio-chemical parameters).	Week-6	Power point presentation, white board illustration, discussion on assignments	Oral viva, interactions	CLO 2, CLO 3
7	**Class Test** Determination of DO consumption	Week-7	— Power point presentation, white board illustration, discussion on assignments	Presentation, interactions	CLO 2, CLO 3
8	Determination of salinity tolerance of	Week-8	Power point presentation,	Sketching the diagrams	CLO 2, CLO 3

	selected aquatic organisms.		white board illustration, discussions on mid-term scripts		
9	Mangrove Study	Week-9	Lecture, Discussion	Class Test/Quiz-2	CLO 2
10	Coral reef ecology	Week-10	Lecture, independent reading	Group assignment	CLO 2, CLO 1
11	Identification of commercially important sea-weeds	Week-11	Power point presentation, white board illustration, interactive Q&A	Brain-storming and performance	CLO 2, CLO 1
12	Identification of commercially important sea-grasses.	Week-12	Power point presentation, white board illustration	Class Test/Quiz-3	CLO 1, CLO 3
13	Coastal organisms in Bangladesh marine waters.	Week-13	Power point presentation, white board illustration, independent reading	Assignment	CLO 1, CLO 3
14	Deep water marine organisms in Bangladesh marine waters.	Week-14	Power point presentation, white board illustration	Group Presentation	CLO 3

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5		3	10
Understand		1	5		3	10
Apply	5				2	10
Analyze		1		2	3	15
Evaluate		1		2	2	10
Create		1		1	2	5

PART D

16) Textbook:

3. Elements of Marine Ecology, by R. V. Tait, F. A. Dipper, Butterworth-Heinemann (4th edition, 1998).
4. Fundamental of Ecology, by E. Odum ,W. B. Gray, Cengage Learning (2004).

17) Reference Books:

1. An Introduction to Marine Science, by P. S. Meadows and J. I. Campbell, Springer.
2. The Oceans: Their Physics, Chemistry, and General Biology, by H. U. Sverdrup, M. W. Johnson, R. H. Fleming, Prentice Hall (1942).

Detail Syllabus Second Semester (Year-1, Semester-2)

Course Title: Physical Oceanography	
Course Code: OCN 1201	**Credit: 3.0**

PART A

1) **Course Code:** OCN 1201
2) **Course Title:** Physical Oceanography
3) **Course Type**: Core Course
4) **Year and Semester:** Year 1, Semester 2
5) **Prerequisite (if any):** N/A
6) **Credits:** 3
7) **Contact Hours:** 42
8) **Total Marks:** 100
9) **Course Summary and Objectives:**

This course introduces the fundamental physical principles governing the ocean, including the physical properties of seawater, circulation mechanisms, interactions with the atmosphere, and wave and ice dynamics. The course emphasizes the ocean's role in Earth's energy budget and climate system.

Course Objectives:

- To understand the physical properties and structure of the ocean.
- To explain key forces and circulation mechanisms governing ocean motion.
- To analyze wind-driven and thermohaline processes.
- To describe wave formation, transformation, and energy transport.
- To introduce the formation, structure, and dynamics of sea ice.
- To explore ocean–atmosphere–cryosphere interactions.

10) **Course Learning Outcomes (CLOs)**

i. **CLO1:** Describe the physical properties of seawater and their role in ocean stratification.
ii. **CLO2:** Explain the vertical structure of the ocean and the processes governing mixing and layering.
iii. **CLO3:** Analyze the key ocean–atmosphere interactions influencing surface processes and circulation.
iv. **CLO4:** Interpret the dynamics of oceanic circulation including geostrophy, Ekman transport, and thermohaline flows.

v. **CLO5:** Evaluate surface and internal wave processes, including wave transformation mechanisms.

vi. **CLO6:** Describe the formation, types, and dynamics of sea ice. *(Understand, Analyze)*

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	**3**	2	2	2	2	1	**3**	2	2
CLO 2	**3**	2	**3**	2	2	2	1	**3**	2	2
CLO 3	**3**	**3**	**3**	**3**	2	2	**3**	2	**3**	2
CLO 4	**3**	**3**	**3**	**3**	2	2	1	2	**3**	2
CLO 5	**3**	2	**3**	**3**	2	2	1	2	**3**	2
CLO 6	**3**	**3**	**3**	2	2	2	1	2	**3**	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1)	Introduction, scope, and milestones in physical oceanography	Week 1	Lecture, Q&A, visual timeline	Quiz, interaction	CLO 1
2)	Physical properties of seawater (salinity, temperature, pressure, density, heat capacity)	Week 2	Lecture, derivation, examples	Quiz, problem set	CLO 1
3)	Ocean stratification and vertical structure	Week 3	Diagram analysis, problem solving	Assignment	CLO 2
4)	Vertical mixing and ocean–atmosphere interactions	Week 4	Case studies, group discussion	Class test	CLO 2
5)	Atmospheric circulation and wind patterns	Week 5	Charts, circulation models	MCQ + written task	CLO 2
6)	Ocean forces and Coriolis effect	Week 6	Problem-solving, demonstration	Quiz	CLO 3
7)	**Mid-Term Examination** Ekman spiral	Week 7	— Physical explanation	Mid-Term Exam (15)	— CLO 3
8)	Ekman transport,	Week	Simulation,	Homework	CLO 3

	upwelling/downwelling	8	mathematical modeling		
9)	Equations of motion and geostrophic balance	Week 9	Derivation + physical explanation	Short answer worksheet	CLO 3
10)	Sverdrup transport, subtropical gyres, boundary currents	Week 10	Concept mapping, current charts	Assignment	CLO 3
11)	Thermohaline circulation and water masses	Week 11	Water mass analysis, mixing demos	Quiz	CLO 4
12)	Ocean waves: generation, transformation, refraction, internal waves	Week 12	Diagrams, wave tank examples, simulations	Class test	CLO 5
13)	Sea ice formation, types (frazil, nilas, etc.), and dynamics	Week 13	Visual interpretation, freezing simulations	Assignment	CLO 6
14)	Integrated review of circulation, waves, and sea ice	Week 14	Synthesis, oral review, Q&A	Final Assignment / Viva	CLO 1–6

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5		3	10
Understand		1	5		3	10
Apply	5				2	10
Analyze		1		2	3	15
Evaluate		1		2	2	10
Create		1		1	2	5

PART D

15) Main Textbooks:

- Stewart, R.H. (2009). *Introduction to Physical Oceanography*. University Press of Florida.
- Pickard, G. L. & Emery, W. J. *Descriptive Physical Oceanography*, Elsevier.

16) Supplementary References:

- Sverdrup, H. U., Johnson, M. W., & Fleming, R. H. *The Oceans: Their Physics, Chemistry, and General Biology*.
- Colling, A. *Ocean Circulation*, Open University.
- Wright, J. *Waves, Tides and Shallow Processes*, Open University.

Course Title: Physical Oceanography Lab	
Course Code: OCN 1202	**Credit: 1.5**

PART A

1) **Course Code:** OCN 1202
2) **Course Title:** Physical Oceanography Lab
3) **Course Type:** SKD
4) **Year and Semester:** Year 1, Semester 2
5) **Prerequisite:** N/A
6) **Credit:** 1.5
7) **Contact Hours:** 42 hours
8) **Total Marks:** 100
9) **Course Summary and Objectives**

   This laboratory course is designed to equip students with practical skills in handling and interpreting oceanographic datasets. The course emphasizes hands-on experience using real-world data sources (e.g., NetCDF, CMEMS, Argo) and software tools (Python, ODV, Excel) to analyze physical properties of the ocean. Students will learn to visualize vertical and horizontal variability, understand wind-current relationships, and interpret CTD and ADCP data.

   Course Objectives

   - To enable students to process and visualize various types of ocean data.
   - To develop practical understanding of ocean structure and variability.
   - To introduce and apply the use of oceanographic instruments in lab settings.
   - To synthesize data into coherent, multi-parameter analysis reports.

10) **Course Learning Outcomes (CLOs)**

    i. CLO1: Generate and interpret vertical profiles and identify ocean layers and mixed depths.
    ii. CLO2: Visualize and interpret horizontal and temporal ocean patterns using satellite/model data.
    iii. CLO3: Operate and interpret data from oceanographic instruments such as CTD and ADCP.
    iv. CLO4: Produce a multi-dimensional oceanographic report using integrated datasets and plots.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	2	**3**	2	2	2	1	1	2	2
CLO 2	**3**	**3**	**3**	**3**	**3**	**3**	2	2	2	2
CLO 3	2	2	2	**3**	**3**	**3**	**3**	**3**	**3**	2
CLO 4	2	2	2	2	2	2	2	2	2	**3**

(Weightage: 3-High, 2-Medium, 1-Low)

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1)	Ocean data types, NetCDF, Excel, Python tools overview	Week 1	Demonstration, walkthrough, tutorial video	Class participation	CLO 1
2)	Plotting vertical profiles (T, S, density); identifying ocean layers	Week 2	Python/ODV practice, instructor support	Assignment	CLO 1
3)	Mixed layer, thermocline, pycnocline detection	Week 3	Real data exercise, peer review	Quiz	CLO 1
4)	Surface plots: SST, SSS, sea level; upwelling and front identification	Week 4	Dataset exploration, guided plotting	Assignment	CLO 2
5)	Section plots and Hovmöller diagrams	Week 5	Python + matplotlib/xarray tasks	Class test	CLO 2
6)	Temporal pattern interpretation (seasonality, ENSO-like signals)	Week 6	Case study, student-led discussion	Quiz	CLO 2
7)	**Class Test (practical-based)**	Week 7	Hands-on test on data visualization/interpretation	Class Test (15 marks)	—
8)	Satellite winds, surface currents, Ekman transport concept	Week 8	Vector plots, divergence zones	Assignment	CLO 2
9)	Oceanographic	Week 9	Instrument demo,	Quiz	CLO 3

	instruments: CTD and ADCP introduction and functionality		hands-on explanation		
10)	Plotting in-house CTD profiles; constructing T-S diagrams	Week 10	Field data plotting in Python/Excel	Report task	CLO 3
11)	Interpreting ADCP; internal wave hints from profiles	Week 11	Time-depth plotting, profile analysis	Homework	CLO 3
12)	Final project orientation and topic/dataset selection	Week 12	Guided planning, dataset curation	Project outline review	CLO 4
13)	Final project development: profile + section + winds + Hovmöller	Week 13	Instructor feedback, independent work	Draft submission	CLO 4
14)	**Viva Voce Examination**	Week 14	Individual oral evaluation	Viva (15 marks)	CLO 4

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**				**Semester Final Examination**
	Attend. (10)	**Class Performance (10)**	**Viva/Presentation (20)**	**Assignment /Lab report (20)**	**Final (40)**
Remember		02	05		05
Understand		02	10	03	05
Apply	10	02		02	05
Analyze		02		05	10
Evaluate		02	05	10	05
Create					10

PART D

13) Suggested Readings

- Stewart, R. H. (2009). *Introduction to Physical Oceanography*. Texas A&M University (Open Access).
- Scharf, F. (2022). *Python for Oceanographers: Ocean Data Processing*.

- Emery, W. J. & Thomson, R. E. (2001). *Data Analysis Methods in Physical Oceanography*. Elsevier.
- Wilks, D. S. (2011). *Statistical Methods in the Atmospheric Sciences*. Academic Press.
- Open-source manuals and user guides (e.g., ODV, Panoply, Python libraries)

Course Title: Biological Oceanography	
Course Code: OCN 1203	**Credit: 3.0**

PART A

1) Course Code: OCN 1203

2) Course Title: Biological Oceanography

3) Course Type: CC

4) Year and Semester: Year 1, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course is designed to get the knowledge about the marine biology. Ocean is a habitat for diverse organisms which play an important role in the overall oceanic processes. The objectives are as follows -

- To know about the factors governing productivity, population dynamics and distribution of organisms in major ecosystems of the ocean.
- To know about various marine organisms including plankton, benthos.
- To learn about classification, occurrence, distribution and characteristics of organisms.
- To know about the migration and productivity of ocean.

10) Course Learning Outcomes (CLO):

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

i. CLO 01: Understand the diversity of marine organisms.
ii. CLO 02: Understand the occurrence, distribution, classification and characteristics of marine organisms.
iii. CLO03: To learn about the migration pattern of organisms and the productivity of the ocean.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / **CLO**	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	1	1	1	1	**3**	**3**	2	1	2	1
CLO 2	1	1	1	1	**3**	**3**	2	1	2	1
CLO 3	1	1	**3**	1	2	2	1	1	2	1

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1.	**Introduction:** • Special properties affecting life in the sea • Classification of marine environments • K-selected and r-selected species and their features • Historical development of Biological Oceanography	Week-1	Lecture, Discussion	Class performance and interactions	CLO 1 CLO 2
2.	**The abiotic environments and its relations to the biological process** • Solar radiation • Temperature, salinity and density • Surface currents	Week-2	Lecture, Discussion, Video Presentation	Assignment	CLO 2 **CLO 3**
3.	**Plankton:** • Definition • Classification • Morphology and physiology of common plankton • Importance of plankton in the ocean	Week-3			
4.	**Plankton:** • Factors affecting the growth and abundance of phytoplankton and zooplankton in the coastal and open water	Week-4	Lecture, Group Discussion	Class Test/Quiz-1	CLO 1 CLO 2 CLO 3

	• Physical Controls of Primary Production (Oceanic Gyres, eddies, and Rings, Convergence and divergence) • Migration of plankton (vertical and diel vertical migration, seasonal migration of zooplankton) • Phytoplankton bloom				
5.	**Marine Invertebrates:** Classification and salient features of major marine invertebrates.	Week-5	Interactive discussion, white board illustration	Presentation, interactions	CLO 1 CLO 2 CLO 3
6.	**Marine Vertebrates:** Classification and salient features of major marine vertebrates.	Week-6	Power point presentation, white board illustration	CT/Quiz-02	CLO 2
7.	**Mid-Term** ▪ General concept and importance of benthos in the ocean	Week-7	– Power point presentation, white board illustration	– Power point presentation, white board illustration	– CLO 1 CLO 2 CLO 3
8.	Benthic communities and their distribution of seafloor	Week-8	Power point presentation, white board illustration, discussion on assignments	Oral viva, interactions, Participation	CLO 1 CLO 2 CLO 3
9.	**Benthic communities** • Environmental conditions and adaptations of intertidal organisms • Benthic flora and fauna and their vertical stratification, aerobic and anaerobic organisms	Week-9	Power point presentation, white board illustration, discussions on mid-term scripts	Sketching the diagrams	CLO 1 CLO 2 CLO 3

10.	**Coral Reefs** • Mechanism of coral formation • Ecology, types and distribution of coral reef	Week-10	Lecture, Discussion	Class Test/Quiz-03	CLO 1 CLO 2 CLO 3
11.	**Coral Reefs** • Coral reef and their relation to flora and fauna • Coral destruction and exploration	Week-11	Lecture, independent reading	Group assignment	CLO 1 CLO 2 CLO 3
12.	**Mangroves** • Ecological features of mangrove swamps • Mangrove biodiversity, and fertility in the sea • Importance and uses of mangroves	Week-12	Power point presentation, white board illustration, interactive Q&A	Brain-storming and performance	CLO 1 CLO 2 CLO 3
13.	**Hydrothermal vents and cold seeps** • Chemosynthesis production • Vent fauna • Unique environmental features of vent communities	Week-13	Power point presentation, white board illustration	Class Test/Quiz-04	CLO 1, CLO 2,
14.	**Human impacts on marine biota** • Marine pollutants (heavy metals, plastics, thermal effluents, sewage, radioactive wastages) • Introducing and transfer of marine organisms	Week-14	Power point presentation, white board illustration, independent reading	Assignment	CLO 2

PART C

13) Assessment and Evaluation

Bloom's Category	Continuous Internal Evaluation					Semester Final Examination
	Attend. (05)	Class Performance (05)	Class Tests (10)	Assign. (05)	Mid Term (15)	Final (60)
Remember		1	5		3	10
Understand		1	5		3	10
Apply	5				2	10
Analyze		1		2	3	15
Evaluate		1		2	2	10
Create		1		1	2	5

PART D

Recommended Text(s):

1. Ecology of Plankton, A. Kumar, Daya Publishing House, ISBN: 8170353742.
2. Biological Oceanographic Processes, T.R. Parsons, M. Takahashi and B. Hargrave, Pergamon, ISBN: 0080307655.
3. Biological Oceanography: An Introduction, by Carol M Lalli& Timothy Parsons, Butterworth-Heinemann, ISBN: 0750633840.
4. Advances in marine biology, by Michael Lesser, Academic Press, ISBN: 0128001690.

Course Title: Biological Oceanography Lab	
Course Code: OCN 1204	Credit: 1.5

PART A

1) Course Code: OCN 1204

2) Course Title: Biological Oceanography Lab

3) Course Type: Core Course

4) Year and Semester: Year 1, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 1.5

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course is designed to get the practical training to understand the marine biology.
To examine the processes governing the distribution, abundances, and production of plants, animals, and nutrients in the oceanic ecosystem.
Course objectives include –

- To learn about the processes of collection, preservation and identification of marine organisms.
- To learn about the techniques of estimating marine productivity.
- To understand the various aspects of biology of the sea.

10) Course Learning Outcomes (CLO):

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

i. **CLO 01:** Collect, preserve and identify marine organisms.
ii. **CLO 02:** Estimate the productivity and biomass.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	1	1	1	1	**3**	2	2	1	1	1
CLO 2	1	1	**3**	2	2	2	1	1	1	1

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	**Introduction**	Week-1	Power point presentation, white board illustration	Assignment	CLO 1, CLO 2
2	Collection, preservation and identification of plankton	Week-2	Conduct Experiment/Live Demonstration	Class performance and interactions	CLO 1,
3	Collection, preservation and identification of plankton	Week-3	Conduct Experiment/Live Demonstration	Class Test/ Quiz-01	CLO 1,
4	Collection, preservation and identification of benthic organisms	Week-4	Conduct Experiment/Live Demonstration	Presentation, interactions	CLO 1,
5	Collection, preservation and identification of benthic organisms	Week-5	Conduct Experiment/Live Demonstration	Assignment	CLO 1,
6	Estimation of productivity	Week-6	Conduct Experiment/Live Demonstration	Oral viva, interactions	CLO 2
7	**Lab Viva**	Week-7			
8	Estimation of POC	Week-8	Conduct Experiment/Live Demonstration	Class performance	CLO 1
9	Estimation of DOC	Week-9	Conduct Experiment/Live Demonstration	Class Test/Quiz-2	CLO 1,
10	Estimation of biomass	Week-10	Conduct Experiment/Live Demonstration	Group assignment	CLO 2
11	Preparation of plankton Slides	Week-11	Conduct Experiment/Live Demonstration	Brain-storming and performance	CLO 1,
12	Preparation of benthic Slides	Week-12	Conduct Experiment/Live Demonstration	Class Test/Quiz-3	CLO 1
13	Field trip for studying the	Week-13	Briefing and demonstration	Report/ Assignment	CLO 1, CLO 2

	marine aquarium and its operation				
14	Recap and Practice	Week-14	Interaction, Q/A	Class Performance	CLO 1, CLO 2

PART C

13) Assessment and Evaluation

Bloom's Category	Continuous Internal Evaluation					Semester Final Examination
	Attend. (10)	Class Performance (10)	Class Tests (10)	Assign. (20)	Viva (10)	Final (40)
Remember		2	2		2	
Understand		2	2	5	2	10
Apply		2	2	5	2	10
Analyze		2	2	5	2	10
Evaluate		2	2	5	2	10
Create						

PART D

Recommended Texts:

1. Global Air Pollution, by H Bridgman, John Wiley & Sons (1990), ISBN: 0471944955.
2. Principles of Air Pollution Methodology, by T Lyons and B Scott.CBS Pub. & Distributor (1992).
3. Atmospheric Chemistry & Physics, by J.H. Seinfeld, John Wiley & Sons (1998), ISBN: 978-1-118-94740-1.
4. Environmental Water Pollution and Control,by**G.R.Chhatwal, M.C. Mehra, Mohan Katyal, T. Katyal, T. Nagahiro,** Anmol Publication, New Delhi, ISBN: 8170412145.
5. Water Pollution, by A. K.Tripallhi, Astish Publication, New Delhi (1990).
6. Assessment of Water Pollution, by S. R. Mishra, APH Publication, New Delhi (1996).
7. River Pollution–an Ecology Perspective, by S. M.Haslam, CBS Publication& Distributor, New Delhi (1990).
8. Standard Methods for the Examination of Water & Wastewater, by APHA (American Public Health Association). Washington. D.C. (1996), ISBN: 0875532292.

Course Title: Mathematics II	
Course Code: OCN 1205	Credit: 2.0

PART A

1) Course Code: OCN 1205

2) Course Title: Mathematics II

3) Course Type: FC

4) Year and Semester: Year 1, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 2

7) Contact Hours: 28

8) Total Marks: 100

9) Course Summary and Objectives:

This course provides fundamental tools in applied mathematics for solving problems. Topics include ordinary and partial differential equations, matrix algebra, and transforms. Students will learn solution techniques for first-order and higher-order ODEs, key PDEs such as wave, heat, diffusion, and Laplace's equations, and applications of Fourier and Laplace transforms. The course also covers matrix operations, eigenvalues, eigenvectors, and diagonalization for solving linear systems and analyzing mathematical models.
Course objectives include –

- To understand and solve ordinary and partial differential equations relevant to scientific problems.
- To apply matrix algebra techniques for solving linear systems and analyzing mathematical models.
- To use Fourier and Laplace transforms for solving boundary value problems and other applications.
- To develop analytical skills for modeling, interpreting, and solving real-world problems.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Solve first-order, higher-order, and series-form ordinary differential equations using appropriate analytical methods.
ii. **CLO 2:** Formulate and solve common partial differential equations such as wave, heat, diffusion, and Laplace's equations.
iii. **CLO 3:** Apply matrix algebra concepts, including eigenvalues, eigenvectors, and diagonalization, to solve linear systems and analyze models.
iv. **CLO 4:** Use Fourier and Laplace transform techniques to solve boundary value problems and interpret results in physical contexts.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	**3**	**3**	2	1	1	1	1	2	2
CLO 2	**3**	2	**3**	**3**	1	1	1	**3**	2	2
CLO 3	2	**3**	**3**	**3**	1	1	1	1	2	2
CLO 4	**3**	2	**3**	**3**	1	1	1	**3**	2	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	First-Order Differential Equations: Solution Methods	Week-1,2,3,4	Lecture, Discussion	Assignment Class Test/Quiz-1	CLO1
2	Higher-Order Linear Differential Equations (Constant Coefficients): Method of Undetermined Coefficients, Variation of Parameters	Week-5	Lecture, Discussion	Class performance and interactions	CLO 1
3	Partial Differential Equations: Wave Equation, Heat Equation,	Week-6, 7	Interactive discussion, white board illustration	Class Test/Quiz-2	CLO 2
4	**Mid-Term Examination** Diffusion Equation, Laplace's Equation	Week-8	— Interactive discussion, white board illustration	— Class performance and interactions	— CLO 2
5	Matrices: Definitions, Types, Operations	Week-10,11	white board illustration	Class Test/Quiz-3	CLO 3
6	Inverse, Rank, Gaussian & Gauss–Jordan Elimination	Week-12	White board illustration, discussion on	Oral viva, interactions	CLO 3

			assignments		
7	Eigenvalues, Eigenvectors, and Diagonalization, Quadratic Forms and Orthogonal Matrices	Week-13	Power point presentation, white board illustration, discussions on mid-term scripts	Class Task	CLO 3
8	Fourier Series (Real and Complex Forms), Fourier Transforms, Finite Fourier Transforms and Fourier Integrals,	Week-14	Lecture, Discussion	Interactions	CLO 4

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5		3	10
Understand		1	5		3	10
Apply	5				2	10
Analyze		1		2	3	15
Evaluate		1		2	2	10
Create		1		1	2	5

PART D

14) Textbook:

Calculus, by Howard Anton, IRL Bivens, Stephen Davis. Wiley (10th edition), ISBN: 1118137922.

15) Reference Books:

1. Differential Calculus, by B. C Das, B. N Mukherjee, U. N. Dhur& Sons Pvt. Ltd (55th edition), ISBN: 9380673876.
2. Integral Calculus, by B. C Das, B. N Mukherjee. (58th edition)
3. A Text Book On Co-ordinate Geometry with Vector Analysis, by A. F. M. Abdur Rahman and P. K. Bhattacharjee. (11th edition)
4. Calculus by Swokowski 6th Edition
5. Differential Calculus 5th Edition - DR MD Abdul Matin
6. Integral Calculus and Differential Equation (5th Edition) by Dr. Md. Abdul Matin

Course Title: Physics II	
Course Code: OCN 1207	Credit: 2

PART A

1) Course Code: OCN 1207

2) Course Title: Physics II

3) Course Type: AC

4) Year and Semester: Year 1, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 2

7) Contact Hours: 28

8) Total Marks: 100

9) Course Summary and Objectives:

This course builds upon fundamental physics concepts introduced in Physics I, expanding into fluid statics and dynamics, wave optics, thermodynamics, and global heat flow relevant to oceanography. Students will learn essential physical principles governing light behavior, energy transfer, and fluid flow, with an emphasis on marine applications.

Course objectives include –

- To understand principles of hydrostatics and fluid motion relevant to marine systems.
- To explore molecular forces influencing surface tension and viscosity.
- To examine wave optics phenomena and their quantitative interpretations.
- To learn core thermodynamic laws and processes and apply them to heat flow problems.
- To understand how oceanic and regional heat flow affects Earth's systems.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Understand and apply the concepts of hydrostatics, fluid flow, and viscosity in marine environments.
ii. **CLO 2:** Explain and analyze wave optics phenomena including interference, diffraction, and polarization.
iii. **CLO 3:** Describe thermodynamic systems and processes and apply the laws of thermodynamics to physical systems.
iv. **CLO 4:** Explain heat flow concepts and evaluate regional and global ocean heat patterns.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	**3**	**3**	**3**	2	2	1	1	2	2
CLO 2	**3**	**3**	**3**	2	**3**	2	1	1	2	2
CLO 3	**3**	**3**	**3**	2	**3**	2	1	1	**3**	2
CLO 4	**3**	**3**	**3**	**3**	**3**	2	1	**3**	**3**	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1)	Hydrostatic pressure, Pascal's law, pressure variation with elevation, floating bodies	Week 1	Board work, derivation, marine examples	Quiz, class interaction	CLO 1
2)	Streamline/turbulent flow, Reynolds number, continuity, Bernoulli's equation	Week 2	Group problem solving, video explanation	Assignment	CLO 1
3)	Poiseuille's equation, Stokes' law, terminal velocity	Week 3	Concept application, visuals	Class test	CLO 1
4)	Surface tension: molecular origin, contact angle, capillarity	Week 4	Demo experiments, whiteboard derivations	Assignment	CLO 1
5)	Wave optics intro, traveling/standing waves, Huygen's principle	Week 5	Simulations, lecture-discussion	Quiz	CLO 2
6)	Interference: Young's double slit, Newton's rings	Week 6	Problem solving, group activity	Quiz	CLO 2
7)	**Mid-Term Examination** Newton's rings	Week 7	— Group activity	Midterm Exam (15%)	— CLO 2
8)	Diffraction: slits, gratings, resolving power	Week 8	Slit demo, mathematical modeling	Assignment	CLO 2
9)	Polarization: types, plane, transmission, attenuation	Week 9	PPT, polarizing films, lab demo	Class test	CLO 2
10)	Thermal equilibrium, internal energy, Zeroth & First Law of Thermodynamics	Week 10	Process graphs, thermodynamic systems	Quiz	CLO 3

11)	Adiabatic/isothermal processes, entropy, Carnot cycle	Week 11	Derivations, engine models	Assignment	CLO 3
12)	Global heat flow, measurement techniques in oceans	Week 12	Satellite data, case studies	Quiz	CLO 4
13)	Surface and regional heat flow variation, local influence	Week 13	Chart analysis, concept applications	Final assignment	CLO 4
14)	Review and integration of thermodynamics and optics concepts	Week 14	Discussion, oral Q&A	Viva Voce / Presentation (15 marks)	CLO 1–4

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5		3	10
Understand		1	5		3	10
Apply	5				2	10
Analyze		1		2	3	15
Evaluate		1		2	2	10
Create		1		1	2	5

PART D

16) Textbook:

- Halliday, D., Resnick, R., & Walker, J. (2014). *Fundamentals of Physics*, 10th Ed., Wiley.

17) Reference Books:

1. Young, H. D., & Freedman, R. A. (2012). *University Physics*, 13th Ed., Pearson.
2. Sears & Zemansky. *College Physics*, Addison-Wesley.
3. Beiser, A. *Concepts of Modern Physics*, McGraw Hill.
4. Feynman, R. P. *Feynman Lectures on Physics*, Vol. I & II.

Course Title: Chemistry II	
Course Code: OCN 1209	Credit: 2.0

1) Course Code: OCN 1209

2) Course Title: Chemistry II

3) Course Type: AC

4) Year and Semester: Year 1, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 2

7) Contact Hours: 28

8) Total Marks: 100

9) Course Summary and Objectives:

A detailed study of basic chemistry including thermodynamics, chemical kinetics, nuclear chemistry, electrochemistry, organic chemistry to develop basic knowledge about the chemistry of natural system, chemistry of organic carbon relevant to living system.

Course objectives include –

- To provide a foundational understanding of chemical principles relevant to oceanographic processes and marine environments.
- To develop students' ability to apply chemical concepts in analyzing and solving real-world marine and environmental chemistry problems.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Understand and apply core chemical principles (thermodynamics, kinetics, redox, equilibria) to oceanographic processes and marine systems.

ii. **CLO 2:** Analyze inorganic and organic chemical behavior in natural waters, including the carbon cycle, trace metals, and pollutants

iii. **CLO 3:** Use chemical knowledge and techniques (e.g., electrochemistry, nuclear chemistry) to study and interpret marine biogeochemical cycles and environmental changes.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	2	2	2	2	2	2	1	1	2	2
CLO 2	2	2	**3**	2	2	2	1	1	2	2
CLO 3	2	2	**3**	**3**	**3**	**3**	1	**3**	2	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Theory and applications of oxidation-reductions systems	Week-1	Lecture, Discussion	Class Test/Quiz-1	CLO 1, CLO 3
2	Thermodynamics	Week-2	Lecture, Discussion	Class Test/Quiz-1	CLO 1
3	Chemical Kinetics	Week-3	Lecture, independent reading	Class Test/Quiz-1	CLO 1, CLO 3
4	Complex equilibria and solubility product	Week-4	Power point presentation, white board illustration, interactive Q&A	Class Test/Quiz-2	
5	Descriptive Inorganic and Organic Chemistry	Week-5 Week-6	Power point presentation, white board illustration, interactive Q&A	Class Test/Quiz-2	CLO 1, CLO 2, CLO 3
6	Mid-Term Examination Descriptive Organic Chemistry	Week-7	— Power point presentation, white board illustration	Mid-term (15)	— CLO 1, CLO 2, CLO 3

7	Nuclear Chemistry	Week-8	Power point presentation, white board illustration	Class Test/Quiz-3	CLO 1, CLO 3
8	Electrochemistry	Week-9	Power point presentation, white board illustration, independent reading	Brain-storming and performance	CLO 1, CLO 3
9	Chemistry of carbon in natural systems	Week-10	Power point presentation, white board illustration	Assignment	CLO 1, CLO 2, CLO 3
10	Chemical reactions	Week-11 Week-12	Lecture, Discussion	Brain-storming and performance	CLO 1, CLO 2, CLO 3
11	Chemistry of organic carbon relevant to living or once living systems	Week-13	Power point presentation, white board illustration, interactive Q&A	Presentation, interactions, Oral viva, interactions	CLO 1, CLO 3
12	Revision class	Week-14	Power point presentation, white board illustration	Group discussion for problem solving of all chapters	CLO 1, CLO 2, CLO 3

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5		3	10
Understand		1	5		3	10
Apply	5				2	10
Analyze		1		2	3	15
Evaluate		1		2	2	10
Create		1		1	2	5

PART D

16) Textbook:

1. Introduction to Modern Inorganic Chemistry, by S.Z. Haider.
2. General Chemistry, by Ebbing & Gammon.
3. Principles of Physical Chemistry, by MM Haque & Molla.
4. Organic Chemistry, by Morrison & Boyd.
5. Essentials of Physical Chemistry, by Bahl & Tuli.

17) Reference Books:

1. Modern Inorganic Chemistry, R. D Madan, S Chand & Co, 1987
2. Selected Topics in Inorganic Chemistry, R. D. Madan, G D Tuli, Wahid U Malik, S Chand & Co, 2010.

Course Title: Port and Shipping Management	
Course Code: OCN 1211	**Credit: 2.0**

PART A

1) Course Code: OCN 1211

2) Course Title: Port and Shipping Management

3) Course Type: AC

4) Year and Semester: Year 1, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 2

7) Contact Hours: 28

8) Total Marks: 100

9) Course Summary and Objectives:

This course introduces the structure, economics, operations, and regulatory frameworks of ports and shipping. It emphasizes the integrated role of maritime transport in global trade and the Blue Economy, with applications to Bangladesh. Students will examine maritime geography, port functions, shipping markets, supply chain integration, environmental concerns, and international conventions. Objectives include -

- To understand the global maritime system and its stakeholders.
- To describe port functions, classifications, and logistics linkages.
- To analyze maritime economics, chartering, and shipping operations.
- To explore environmental and legal aspects of port and shipping management.
- To relate maritime transport to sustainable development and global challenges.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Explain the role of maritime transport, key stakeholders, and the relevance of the Blue Economy.
ii. **CLO 2:** Describe port classifications, functions, layouts, and their role in global logistics chains.
iii. **CLO 3:** Analyze core shipping operations including ship types, markets, chartering, and economics.
iv. **CLO 4:** Interpret major environmental impacts and legal conventions regulating port and shipping operations.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	2	**3**	2	2	1	1	1	**3**	**3**	**3**
CLO 2	**3**	**3**	**3**	**3**	1	1	1	1	2	2
CLO 3	**3**	**3**	**3**	**3**	1	1	1	2	**3**	**3**
CLO 4	2	**3**	**3**	2	1	2	2	**3**	**3**	**3**

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Introduction to maritime studies, global maritime systems, key stakeholders, Bangladesh Blue Economy context	Week 1	Lecture, real-world cases, map-based discussion	Class interaction, quiz	CLO 1
2	Maritime geography, major global trade routes, choke points	Week 2	Visual aids, GIS maps, group Q&A	Short test, discussion task	CLO 1
3	Port functions, types (hub/feeder), governance structures	Week 3	Diagram analysis, classification exercises	Assignment	CLO 2
4	Port layout, connectivity, and terminal planning, Port automation.	Week 4	Case study analysis, port simulation walkthrough	Class test	CLO 2
5	Ship types and cargo classification, basics of chartering (voyage/time/bareboat)	Week 5	Interactive lecture, charter case comparison	MCQ and short answers	CLO 3
6	Freight markets, shipping cycles,	Week 6	Economic modeling, news brief discussion	Group quiz	CLO 3
7	**Mid-Term Examination** Supply-demand in maritime economics	Week 7	— Economic modeling, news brief discussion	Mid-Term Exam (15%)	— CLO 3

8	Ports as logistics centers, supply chain functions, multimodal transport	Week 8	Logistics diagrams, Bangladesh case discussion	Assignment	CLO 2
9	3PL, 4PL roles, supply chain integration (SCI)	Week 9	Role-play, flow diagrams	Class task	CLO 2
10	Environmental issues: dredging, port emissions, green ports	Week 10	Documentary + discussion, real case analysis	Quiz	CLO 4
11	Ship-source pollution and MARPOL conventions	Week 11	Legal brief, IMO case simulation	Assignment	CLO 4
12	Ballast water and invasive species: IMO BWM Convention	Week 12	Impact map, group debate	Written reflection	CLO 4
13	Climate change and maritime operations: Arctic routes, infrastructure adaptation	Week 13	Satellite imagery review, scenario planning	Quiz	CLO 4
14	Review session + Student presentations on assigned shipping/port topic	Week 14	Student-led presentation, peer review	Final project presentation	CLO 1–4

PART C

15) Assessment and Evaluation

Bloom's Category	Continuous Internal Evaluation					Semester Final Examination
	Attend. (05)	Class Performance (05)	Class Tests (10)	Assign. (05)	Mid Term (15)	Final (60)
Remember		1	2			10
Understand		1	5		5	10
Apply		1			5	15
Analyze		1		3	5	15
Evaluate		1	3	2		10
Create						

PART D

Reference books:

- Alderton, P. (2008). *Port Management and Operations* (3rd Edition). Informa Law.
- Talley, W. K. (2009). *Port Economics*. Routledge.
- UNCTAD. (2023). *Review of Maritime Transport*.

- IMO. *MARPOL and Ballast Water Management Conventions*.
- Rodrigue, J. P. (2020). *The Geography of Transport Systems*. Routledge.

Course Title: Viva-voce	
Course Code: OCN 1212	**Credit: 1.5**

PART-A

1) **Course Code:** OCN 1212

2) **Course Title:** Viva-Voce

3) **Course Type:** FC

4) **Year and Semester:** Year 1, Semester 2

5) **Prerequisite (if any):** N/A

6) **Credit Value:** 1.5

7) **Contact Hours:** N/A

8) **Total Marks:** 100

Viva voce will be conducted towards the end of the academic year which will be covering the complete syllabus. This will assess the student's knowledge and understanding during the course of their graduate programme. In doing so, the main objective of this course is to prepare the students to face interview both at the academic and the professional arenas.

9) **Course Objectives:**

The primary aim of the course is to develop students' confidence in oral assessments and to evaluate the conceptual understanding gained during their first year of undergraduate education.

10) **Course Learning Outcomes (CLOs):**

Upon successful completion of the course the students will be able to:

i. **CLO1:** To describe and explain their understanding of the theoretical and practical fundamental courses.
ii. **CLO2:** Get prepared to face the interview both at the academic and the professional arenas.

11) **Mapping of CLOs with Program Learning Outcomes (PLOs):**

PLO / **CLO**	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	2	**3**	**3**	2	2	2	**3**	2	2
CLO 2	2	2	2	2	2	2	2	**3**	2	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) **Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques**

Course Contents	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1. Comprehensive assessment of all courses offered in the first year, spanning both the first and second semesters.	Viva	Oral Exam	CLO 1, CLO 2

Course Title: Field Work I: Field Methods in Oceanography	
Course Code: OCN 1213	**Credit: 1.5**

PART A

1) **Course Code:** OCN 1213

2) **Course Title:** Field Methods in Oceanography

3) **Course Type:** SKD

4) **Year and Semester:** Year 1, Semester 2

5) **Prerequisite (if any):** N/A

6) **Credit Value:** 1.5

7) **Contact Hours:** 42

8) **Total Marks:** 100

9) **Course Summary and Objectives:**

This course would provide knowledge and hands-on experience of oceanographic processes and morphology of the coastal zone and sampling techniques of basic parameters from Physical, Chemical and Ecological arena. It introduces students to the study of coastal oceanic process with a focus on physical, chemical and geomorphological processes in the nearshore and how various ecosystems response with those changes/processes.

- Learn hands-on sampling techniques and study area determination.
- Gain knowledge about coastal process (physical, chemical, geomorphology) and ecosystems
- Learn scientific methods of biological sample preservation and systematics approaches of its identification.
- Identify the primary processes that shape the coastal zone and drive changes in coastal morphology

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Learn hands-on sampling techniques and study area determination.
ii. **CLO 2:** Gain knowledge about coastal process (physical, chemical, geomorphology) and ecosystems
iii. **CLO 3:** Learn scientific methods of biological sample preservation and systematics approaches of its identification.
iv. **CLO 4:** Identify the primary processes that shape the coastal zone and drive changes in coastal morphology

13) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	3	1	2	1	2	2	3	3	3	2
CLO 2	2	1	2	2	3	1	2	2	3	1
CLO 3	2	2	2	1	3	1	2	3	3	1
CLO 4	2	2	2	1	2	2	2	2	3	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

14) **Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques**

Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1. Introduction to oceanographic instruments 2. Deployment of oceanographic instrument and data acquisition techniques 3. Safety management during oceanographic sampling		Lectures, Hands-On	Field Performance, Report submission, Presentation	CLO 1, CLO 2, CLO 4
4. Selection of study area 5. Sampling techniques of physical, chemical parameters 6. Biological sampling techniques, preservation method and identification		Lectures, Hands-On	Field Performance, Laboratory evaluation, Report submission	CLO 1, CLO 2, CLO 3, CLO 4

PART C

15) **Assessment and Evaluation**

Bloom's Category	**Semester Final Examination**			
	Attendance (10)	**Field Performance (30)**	**Report (40)**	**Presentation / Viva (20)**
Remember		5	5	5
Understand		5	5	5
Apply	10	5	5	5
Analyze		5	5	5
Evaluate		5	5	
Create		5	5	

PART D

16) Reference Books

- Introduction to Coastal Processes and Geomorphology, by Robin Davidson-Arnott, Cambridge University Press, ISBN: 0521696712.
- Beach Processes and Sedimentation (2nd Ed.) by Paul Komar, 1998, Prentice-Hall
- Fundamental of Ecology by Odum.

Detail Syllabus Third Semester
(Year-2, Semester-1)

Course Title: River and Delta Systems	
Course Code: OCN 2101	**Credit: 2.0**

PART A

1) **Course Code:** OCN 2101
2) **Course Title:** River and Delta Systems
3) **Course Type:** FC
4) **Year and Semester:** Year 2, Semester 1
5) **Prerequisite (if any):** None
6) **Credit:** 2
7) **Contact Hours:** 28 hours
8) **Total Marks:** 100
9) **Course Summary and Objectives**

This course introduces students to the geomorphology, dynamics, and management of river systems and deltas. Topics include river formation, channel morphology, discharge measurement, delta-building processes, estuarine interactions, and practical tools like remote sensing and GIS for monitoring riverine environments. The course emphasizes both foundational theory and application to real-world systems such as the Ganges–Brahmaputra–Meghna delta.

Course Objectives

- To describe river types, landforms, and the processes that shape fluvial environments.
- To explain delta formation, variability, and delta–sea interactions.
- To understand river discharge variability and its role in sediment transport and flooding.
- To apply field methods, remote sensing, and GIS for river and delta analysis.

10) Course Learning Outcomes (CLO)

i. CLO1: Explain river classification, morphology, and fluvial landform development.
ii. CLO2: Analyze meandering and channel migration processes using theoretical and visual tools.
iii. CLO3: Evaluate river discharge variability and its geomorphological and hydrological impacts.
iv. CLO4: Describe delta types, delta-building processes, and estuarine interactions.
v. CLO5: Apply GIS, remote sensing, and field data to river and delta system interpretation.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	1	3	3	1	1	1	3	1	2	1
CLO 2	1	3	3	1	1	1	3	1	3	1
CLO 3	3	1	3	3	1	1	1	1	3	1
CLO 4	3	3	3	1	1	1	1	3	3	1
CLO 5	3	3	3	3	2	1	3	3	3	3

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Introduction to river systems; classification; components; fluvial landforms	Week 1	Lecture, maps, diagrams	Quiz	CLO 1
2	Erosional/depositional processes; river origin and types	Week 2	Process visualization, group discussion	Assignment	CLO 1
3	River profiles and drainage patterns; watershed delineation	Week 3	Hands-on sketching; satellite image analysis	Class test	CLO 1
4	Meandering and channel morphology: helicoidal flow, erosion, deposition	Week 4	Diagrams, animation, case examples	Quiz	CLO 2
5	Channel types: straight, braided, anastomosing; lateral migration; bank erosion	Week 5	Videos, aerial imagery, group presentation	Assignment	CLO 2
6	River discharge: components, measurement,	Week 6	Real-world data,	Short test	CLO 3

			calculation practice		
7	**Mid-Term Examination** Seasonal/climatic variability	Week 7	— Real-world data, calculation practice	Mid-Term Exam	— CLO 3
8	Discharge impacts: flooding, sediment flux, delta building	Week 8	Bangladesh examples, historical data	Quiz	CLO 3
9	Delta types and formation: arcuate, bird-foot, cuspate, estuarine	Week 9	Comparative delta profiles	Assignment	CLO 4
10	Deltaic processes and factors: sediment load, wave/tide action	Week 10	Global examples, sediment animation	Class test	CLO 4
11	River–delta–sea interactions; estuarine dynamics and salinity intrusion	Week 11	Diagrams + video clips	Short answer task	CLO 4
12	Case study: Ganges–Brahmaputra–Meghna Delta; policy overview (BDP 2100, treaties)	Week 12	Case discussion, policy brief	Policy review presentation	CLO 4
13	Field methods: water levels, sediment sampling; ADCP; rating curves	Week 13	Field method discussion, videos	Quiz	CLO 5
14	Remote sensing/GIS for river-delta systems; drone, land cover mapping, channel migration	Week 14	Satellite data lab-style lecture	Final assignment	CLO 5

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	2		2	10
Understand		1	2	1	3	10
Apply	5	1	2	1	2	15
Analyze		1	2	1	3	15

Evaluate		1		1	2	5
Create			2	1	3	5

PART D

Reference books:

- Knighton, D. (2014). Fluvial Forms and Processes: A New Perspective. Routledge.
- Bridge, J.S. (2009). Rivers and Floodplains: Forms, Processes, and Sedimentary Record. Wiley-Blackwell.
- Sinha, R. (2022). Ganga River Basin Environmental Management. Springer.
- Bangladesh Delta Plan 2100 Policy Documents
- Scientific articles and remote sensing tutorials for river studies

Course Title: Geological Oceanography	
Course Code: OCN 2103	**Credit: 3.0**

PART A

1) Course Code: OCN 2103

2) Course Title: Geological Oceanography

3) Course Type: CC

5) Year and Semester: Year 2, Semester 1

6) Prerequisite (if any): N/A

7) Credit: 3

8) Contact Hours: 42

9) Total Marks: 100

10) Course Summary and Objectives:

The course presents background material that graduate students are expected to know in the disciplines of geological oceanography, including the scientific method, plate tectonics, minerals, rocks and their formation processes, solid earth processes, natural disasters, surface processes, and geologic time and builds on this material to give a sense of the current state of the science in these fields. Objectives include -

- To learn about the geological processes operating for the evolution of the oceans, the formation of the ocean basins and its resources.
- To learn about plate tectonics and seafloor spreading.
- To know about various geologic features associated with the oceanic crust and physiographic features associated with the ocean floor.

11) Course Learning Outcomes (CLO):

i. **CLO 1:** Learn the history and evolution of the oceans and seas and the role of tectonics and seafloor spreading.
ii. **CLO 2:** Learn the geological and physiographical features and the processes for their formation.
iii. **CLO 3:** Apply knowledge of plate tectonics to explain the formation of ocean basins and their change through time
iv. **CLO 4:** Apply technical knowledge of relevant applications, laboratory methods, and field methods to solve real-world problems in geology

12) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	**3**	**3**	**3**	1	1	**3**	**3**	**3**	**3**
CLO 2	1	**3**	**3**	**3**	**3**	1	**3**	**3**	**3**	**3**
CLO 3	**3**	1	**3**	**3**	**3**	1	**3**	**3**	**3**	2
CLO 4	1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

13) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	**Introduction to Geological Oceanography:** definition, scope, subfields– Geological Time Scale and methods of geological dating– Earth's shape, dimensions, hypsometry, and distribution of land and sea	Week-1	Lecture, Discussion	Assignment	CLO 1
2	**Origin of the Universe and Earth:** ● Big Bang Theory and cosmic evolution. ● Formation of the solar system: nebular hypothesis. ● Earth's accretion and differentiation.	Week-2	Lecture, Discussion	Assignment	CLO 1
3	**Earth's Internal Structures:** ● Compositional layers: crust, mantle, core. ● Mechanical layers: lithosphere, asthenosphere, mesosphere, and core.	Week-3	Lecture, Discussion, Video Presentation	Class performance and interactions	CLO 1, CLO 3

	● Evidence for Earth's internal structure (seismic data, heat flow, etc.). **Earth's Surface Processes:** the origin of the ocean, Formation of the Ocean, Earth's sphere: Hydrosphere, hydrological cycle, processes.				
4	**Continental Drift, Seafloor Spreading, and Plate Tectonics:** • Historical background: continental drift, paleomagnetism and seafloor spreading. • Components of plate tectonics: lithospheric plates, asthenosphere, and driving mechanisms. plate motion and hot spots, convection currents, • Plate Boundaries and Associated Features	Week-4 Week 5	Lecture, Group Discussion	Class Test/Quiz-1	CLO 2, CLO 3
	Introduction to Minerals and Rocks ● Definition of minerals and rocks ● Common rock forming minerals and their composition ● Major types of rocks and classification of each type ● Rock cycle	Week 6	Interactive discussion, whiteboard illustration	Presentation, interactions	
5	**Physical features of continent and ocean:** Description of Continental Margins: Continental shelf, slope, rise, and abyssal plains, ridge, trench, fracture zone, fault, sea mount, island arc, abyssal hill, guyot, abyssal plain, and Submarine canyons, shelf break. Types of Continental	Week 7-8	Interactive discussion, whiteboard illustration	Presentation, interactions	CLO 1, CLO 3

	margin: Active Margin, Passive margin.				
6	**Mid-Term Examination** Features: Ocean basin, Mid-oceanic ridge, Subduction zone, trenches, Ocean basins, Island arcs, Hot spots, Mantle Plume, Transform faults, and Triple junction.	Week-9	— Interactive discussion, whiteboard illustration	— Presentation, interactions	— CLO 1, CLO 3
7	**Weathering and Mass Wasting:** ● Physical and chemical weathering processes. ● Mass wasting: types (slides, flows, falls) and triggers. **Soil Formation and Characteristics:** Soil horizons and profiles.	Week 10	Interactive discussion, whiteboard illustration	Presentation, interactions	CLO 2, CLO 4
8	**Seismic Waves and Their Characteristics:** Types of seismic waves (P, S, surface waves). Wave propagation. Seismographs and seismograms. **Earthquake:** Causes of earthquakes: stress, strain, and plate tectonics. Distribution of earthquake and relation to plate tectonics Measuring earthquakes: magnitude, intensity, and seismic hazards.	Week 11	PowerPoint presentation, whiteboard illustration, discussions on mid-term scripts	Sketching the diagrams	CLO 2, CLO 4
9	**Structural Mechanical Principles:** Force, pressure, stress, and strain. Physical properties of rocks. Stress-strain diagrams. Factors controlling rock behavior. Fold, Fault, joint and unconformity	Week-12	Lecture, Discussion	Class Test/Quiz-2	CLO 4

10	**Basic Concepts:** • Mountain Building and Isostasy • Volcanoes and Volcanism- Magma formation and types. • Tsunamis • Turbidity Currents • Deep Sea Fan.	Week 13	Lecture, Discussion		CLO 1, CLO 3
11	**Basin formation:** Wilson cycle	Week 14	Lecture, independent reading		CLO 1, CLO 3

PART C

14) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5			10
Understand		1	5		5	10
Apply		1			5	15
Analyze		1		3	2	15
Evaluate		1		2	2	10
Create					1	

PART D

15) Reference Books:

1. Plummer, C., Carlson, D., Hammersley, L. (2015) Physical Geology (15th Edition). McGraw-Hill Education
2. Marine Geology, by J. P. Kennett, Prentice Hall, ISBN: 0135569362.
3. Introductory oceanography by Harold V. Thurman, Macmillan Publishing Company.
4. Geological Oceanography: evolution of coasts, continental margins and the deep sea floor, by Francis P. Shepard, Harper & Row, ISBN: 0060460911.
5. Tarbuck, E. J., Lutgens F.K., Tasa, D. G. (2013) Earth: An Introduction to Physical Geology (11th Edition). Pearson.
6. Mason, B., & Berry, L.G. (1968) Elements of Mineralogy. Freeman, W. H. & Company.

Course Title: Geological Oceanography Lab	
Course Code: OCN 2104	**Credit: 1.5**

PART A

1) Course Code: OCN 2104

2) Course Title: Geological Oceanography Lab

3) Course Type: Core Course

4) Year and Semester: Year 2, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 1.5

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course provides practical training on the geology of the ocean. They would collect data, analyze, interpret and prepare maps and charts.

- To understand and to solve practical problems about sea and ocean.
- Identification of geological features of the ocean basins from seismic sections.
- Interpretation of tectonics of the ocean basins from seismic data.
- Determination of the features of the ocean bed from bathymetric data.
- Practical of maps and map readings, basin structure and tectonics. Contour and contour map preparation.
- Data collection, analysis and interpretation

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Understand the bathymetric measurements and charts

ii. **CLO 2:** Geological Mapping scale, interpretation-related equation and preparing various topographical maps and diagrams.

iii. **CLO 3:** Evaluate Geological map cross-section and stratigraphy interpretation

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	1	1	1	1	**3**	**3**	2	2	2	1
CLO 2	**3**	1	**3**	1	**3**	2	1	2	2	1
CLO 3	1	1	1	1	**3**	**3**	**3**	2	2	1
CLO 4	1	**3**	1	1	1	1	1	**3**	1	1

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Introduction and scope	Week-1	Lecture, Discussion	Assignment	CLO 1
2	Scale, Geographic coordinates, Bearing and Azimuth.	Week-2	Lecture, Discussion, Video Presentation	Class performance and interactions	CLO 1, CLO 3
4	Preparation of Bathymetric charts and interpretation.				
5	Contour and contour map preparation. Preparation of geological maps including isopach and structural.	Week-4	Interactive discussion, whiteboard illustration	Presentation, interactions	CLO 1, CLO 2
6	Cross section mapping of Geological bed structures(Homocline bed, Fault)	Week 5-6	Power point presentation, whiteboard illustration	Assignment	CLO 2, CLO 4
8	**Class Test**	Week-7			

9	Identification of geological features of the ocean basins.	Week-8	Power point presentation, whiteboard illustration, discussions on mid-term scripts	Sketching the diagrams	CLO 2, CLO 4
10	Interpretation of tectonics of the ocean basins from seismic data.	Week-9	Lecture, Discussion	Class Test/Quiz-2	CLO 1

PART C

13) Assessment and Evaluation

Bloom's Category	Continuous Internal Evaluation					Semester Final Examination
	Attend. (10)	Class Performance (10)	Class Tests (10)	Assign. (20)	Viva	Final (40)
Remember		1	2	2	2	5
Understand		1	5	5	2	5
Apply		1	3	5	2	10
Analyze		1		3	2	5
Evaluate		2		2	2	5
Create		4		3		10

PART D

Reference Books:

1. Marine Geology, by H. Kuenen, Read Books (2008), ISBN: 1443725102.
2. Submarine Geology, by F. P. Shepard, Harper & Row, 1973, ISBN: 0060460911.
3. Marine Geology, by J. P. Kennett, Prentice Hall, ISBN: 0135569362.
4. Sea level, Land Levels and Tide Gauges, by K. O. Emery, D. G. Aubrey, Springer- verlag, New york, ISBN: 978-1-4613-9103-6.
5. The Sea Floor ---- An Introduction to Marine Geology, by E. Seibold and W. ll. Berger, Springer, ISBN: 3540601910.
6. Geological Oceanography: evolution of coasts, continental margins and the deep sea floor, by Francis P. Shepard, Harper & Row, ISBN: 0060460911.
7. Kearney, P., Klepeis, K.A., and Vine, F.J., 2008, Global Tectonics, 3rd edition, WileyBlackwell, Chichester, UK, 482 p..

Course Title: Statistics	
Course Code: OCN 2105	Credit: 3.0

PART A

1) Course Code: OCN 2105

2) Course Title: Statistics

3) Course Type: CC

4) Year and Semester: Year 2, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course introduces students to the fundamental concepts and methods of statistics, with a focus on their application in scientific research, particularly within Earth and Ocean Sciences. Topics include descriptive statistics, probability theory, inferential statistics, hypothesis testing, regression analysis, and an introduction to statistical software. The course emphasizes understanding statistical reasoning and applying appropriate statistical techniques to real-world data.

10) Course Learning Outcomes (CLO):

- **CLO 1:** Understand and apply descriptive statistical methods to summarize data.
- **CLO 2:** Grasp basic probability concepts and distributions, and apply them to environmental data analysis.
- **CLO 3:** Perform inferential statistical analyses, including confidence intervals and hypothesis tests.
- **CLO 4:** Apply linear regression techniques to model relationships between variables in Earth and Ocean Science data.
- **CLO 5:** Utilize statistical software (e.g., R, Python with statistical libraries) for data analysis and effectively interpret the results.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	**3**	**3**	2	**3**	**3**	1	2	**3**	**3**
CLO 2	**3**	2	**3**	1	2	2	**3**	1	2	**3**
CLO 3	2	**3**	2	**3**	1	2	**3**	1	**3**	**3**
CLO 4	**3**	2	**3**	2	1	2	1	1	2	2
CLO 5	**3**	**3**	2	1	**3**	2	1	2	**3**	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Introduction to Statistics: What is Statistics? The role of statistics in scientific research. Types of data: Qualitative and Quantitative. Populations and Samples. Overview of statistical software. (with Oceanographic examples)	Week-1	Lecture, Discussion	Assignment on the role of statistics in research	CLO 1
2	Descriptive Statistics: Measures of Central Tendency: Mean, Median, Mode. Measures of Dispersion: Range, Variance, Standard Deviation, Interquartile Range. Data Visualization: Histograms, Box Plots, Scatter Plots. (with Oceanographic examples)	Week-2	Lecture, Hands-on Coding	Quiz on descriptive statistics and data visualization	CLO 1
3	Probability Theory: Basic Probability Concepts: Events, Sample Space. Rules of Probability: Addition Rule, Multiplication Rule. Random Variables: Discrete and Continuous. Probability Distributions: Binomial, Poisson, Normal Distribution. (with Oceanographic examples)	Week-3-4	Lecture, Group Discussion	Class test on probability theory and distributions	CLO 2
4	Sampling and Sampling Distributions: Sampling Methods: Random Sampling, Stratified Sampling. Sampling Distribution of the Mean. Standard Error. (with Oceanographic examples)	Week-5	Lecture, Hands-on Exercises	Lab work on sampling distributions and hypothesis testing	CLO 2, CLO 3
5	Inferential Statistics: Estimation: Point Estimation, Confidence Intervals for Means and Proportions. Determining Sample Size.	Week-6	Lecture, Group Discussion	Class test on confidence intervals and sample size	CLO 3

	(with Oceanographic examples)				
6	Mid-Term Examination Inferential Statistics: Hypothesis Testing: Null and Alternative Hypotheses. Type I and Type II Errors. One-sample and Two-sample t-tests. Paired t-tests. Chi-squared tests for categorical data. ANOVA for comparing multiple means. (with Oceanographic examples)	Week-7-8	— Lecture, Case Studies	— Lab report on hypothesis testing with real-world data	— CLO 3
7	Correlation and Regression Analysis: Scatter Plots and Correlation Coefficient. Simple Linear Regression: Model, Assumptions, Interpretation. Coefficient of Determination (R-squared). Introduction to Multiple Linear Regression. (with Oceanographic examples)	Week-9-10	Lecture, Hands-on Coding	Project work on linear regression with Earth/Ocean data	CLO 4
8	Introduction to Statistical Software: Hands-on exercises using R or Python (SciPy, StatsModels). Data import and export. Performing statistical tests and generating plots. (with Oceanographic examples)	Week-11-12	Lecture, Hands-on Exercises	Class test on using statistical software	CLO 5

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	2		2	10
Understand		1	2	1	3	10
Apply	5	1	2	1	2	15
Analyze		1	2	1	3	15
Evaluate		1		1	2	5
Create			2	1	3	5

PART D

Reference Books:

- Rumsey, D. (2011). *Statistics for Dummies*. Wiley.
- Spiegelhalter, D. (2019). *The Art of Statistics: How to Learn from Data*. Penguin.

Course Title: Marine Renewable Energy	
Course Code: OCN 2107	**Credit: 2.0**

PART A

1) Course Code: OCN 2107

2) Course Title: Marine Renewable Energy

3) Course Type: FC

4) Year and Semester: Year 2, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 2

7) Contact Hours: 28

8) Total Marks: 100

9) Course Summary and Objectives:

This course provides a comprehensive introduction to renewable ocean energy systems, including offshore wind, wave, tidal, Ocean Thermal Energy Conversion (OTEC), and salinity gradient energy. It covers the fundamental principles, technologies, historical development, and operational mechanisms of ocean energy devices. The course also addresses the technical, environmental, and socio-economic impacts of ocean energy projects, including installation, maintenance, policy frameworks, and life-cycle economic assessments.

Course objectives include –

- Understand the fundamental principles, technologies, and historical development of renewable ocean energy systems.
- Apply and analyze theoretical and practical concepts to evaluate the performance, operation, and environmental impacts of ocean energy devices.
- Assess and integrate economic, policy, and sustainability considerations to support decision-making in renewable ocean energy projects.

10) Course Learning Outcomes (CLO):

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

i. **CLO 1** – Explain the fundamental principles, technologies, and historical development of various renewable ocean energy systems including wind, wave, tidal, OTEC, and salinity gradient energy.
ii. **CLO 2** – Apply theoretical concepts (e.g., wave theory, tidal laws, turbine mechanics) to analyze energy conversion processes, device operation, and system performance.
iii. **CLO 3** – Evaluate the technical, environmental, and socio-economic impacts of deploying renewable ocean energy systems, including installation, maintenance, and policy frameworks.
iv. **CLO 4** – Demonstrate the ability to conduct basic economic and life-cycle assessments for renewable ocean energy projects, including cost estimation, financing, and sustainability considerations

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	1	**3**	1	1	2	1	1	**3**	2	2
CLO 2	**3**	1	**3**	**3**	2	2	1	2	2	2
CLO 3	2	1	2	1	2	**3**	**3**	2	**3**	2
CLO 4	1	1	2	1	2	**3**	2	2	**3**	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	**Introduction to renewable ocean energy** - an overview and history of ocean energy conversion methods, the market, costs, legislation and current trends.	Week-1	Lecture, Discussion	Participation	CLO 1
2	**Offshore wind energy:** turbine types, fundamentals of operation, airfoils and blades, blade-element momentum theory, device- and farm-scale flow phenomena, . Floating wind foundations, installation and maintenance, logistics and decommissioning, environmental impact	Week-2	Lecture, Discussion, Video Presentation	Class performance and interactions	CLO 1, CLO 2, CLO 3
3	**Ocean surface waves**: Wave measurement; Linear wave theory; Wave spectrum; Wave energy resource; Floating wave energy converters and oscillating water columns; Wave energy conversion	Week-3	Lecture, Group Discussion	Class Test/Quiz-1	CLO 1, CLO 2

	(wave resource, wave devices, practical resource)				
4	**Ocean tidal currents**: Current measurement; Current turbulence; Current energy resource. Tidal power. Basic laws of tidal energy generation, transport and dissipation. Harnessing the power of tides for the generation of electricity.	Week-4 Week-5	Interactive discussion, white board illustration	Presentation, interactions	CLO 1, CLO 2, CLO 3
5	**Ocean tidal currents:** The methods for evaluation environmental impact of a tidal power development.	Week-6	Power point presentation, white board illustration	Assignment	CLO 1, CLO 2, CLO 3
6	**Mid-Term Examination** Marine current conversion (tidal resource, tidal devices, practical resource)	Week-7	— Power point presentation, white board illustration	— Assignment	— CLO 1, CLO 2, CLO 3
7	**Tidal energy:** barrages vs. current, device concepts, channel flow, effects of a free-surface, turbulence, fluctuating loads	Week-8	Power point presentation, white board illustration, discussion on assignments	Oral viva, interactions	CLO 2
8	**Other types of energy systems**: Ocean Thermal Energy Conversion (OTEC); Energy from salinity gradient, IoT-enabled energy platforms.	Week-9	Power point presentation, white board illustration, discussions on mid-term scripts	Group presentation	CLO 1
9	**Power take-off systems**: Air turbines, Water turbines; High pressure hydraulic systems; Electrical generation; Energy storage	Week-10	Power point presentation, white board illustration, group discussion	Class Test/Quiz-2	CLO 2
10	**Mooring and anchoring systems**: Farm layout. Offshore electrical grid and connection systems. Operation and maintenance of ocean energy devices. Offshore operations. Maritime safety issues	Week-11	Lecture, Discussion	Sketching the diagrams	CLO 2, CLO 3

11	**Economic analysis:** Cost, Financing mechanisms; Economic evaluation; Life -cycle assessment	Week-12	Lecture, independent reading	Class Test/ Quiz-3	CLO 4
12	**Policy issues:** Socio-economic impact; Licensing & permitting; Environmental impact assessment	Week-13	Power point presentation, white board illustration, interactive Q&A	Brain-storming and performance	CLO 3, CLO 4
13.	**Revision Class**	Week-14	Interactive discussion, white board illustration	Group discussion	CLO 1, CLO 2, CLO 3, CLO 4

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5		3	10
Understand		1	5		3	10
Apply	5				2	10
Analyze		1		2	3	15
Evaluate		1		2	2	10
Create		1		1	2	5

PART D

Recommended Texts:

1. Twidell, J. and Weir, T. (2006) Renewable Energy Resources. Second Edition. Taylor and Francis Group.
2. Boyle, G. (2005) Renewable energy power for a sustainable future. Second Edition. Oxford University Press.
3. Massey, B.S., 2005 Mechanics of fluids, 8th edition, (revised by Ward-Smith, J.). Taylor and Francis, ISBN 0-415-36206-7
4. White, F.M., 2006, Fluid Mechanics, 6th Edition, McGraw-Hill, ISBN 0-071-28646-2.

5. Dean, R.G. and Dalrymple, R.A., (1991) Water wave mechanics for engineers and scientists, World Scientific.
6. Walker J and Jenkins N (1997) Wind Energy Technology. Wiley Unesco Energy Engineering Series.
7. Manwell JF, McGowan, JG and Rogers, AL.(2010) Wind Energy explained: Theory, Design and Application. Wiley. 2nd Edition. ISBN0-470-01500-4
8. Cruz, J. (2007) Ocean Wave Energy: Current Status and Future Perspectives. SpringerBerlin.
9. Falnes, J., 2002. Ocean Waves and Oscillating Systems: Linear Interactions Including Wave
10. Energy Extraction. Cambridge University Press, Cambridge. Baker AC (1981) Tid

Course Title: Chemical Oceanography	
Course Code: OCN 2109	**Credit: 3.0**

PART A

1) Course Code: OCN 2109

2) Course Title: Chemical Oceanography

3) Course Type: CC

4) Year and Semester: Year 2, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course covers the chemical composition and properties of seawater, including major and minor constituents, dissolved gases, nutrients, and organic matter. It explores the processes that control their distribution and cycling, examines radioactivity in seawater, and discusses the extraction of useful substances from the sea. Special focus is given to the chemical features of the Indian Ocean and the Bay of Bengal.
Course objectives include –

- To understand the chemical composition and properties of seawater.
- To learn about the sources, distribution, and cycling of major and minor constituents in the ocean.
- To explore the role of dissolved gases, nutrients, and organic matter in ocean processes.
- To study the occurrence and significance of radioactivity in seawater.
- To know the chemical characteristics of regional seas, particularly the Indian Ocean and Bay of Bengal.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Learn about the history, scope, and physical and chemical properties of seawater.
ii. **CLO 2:** Know about major and minor constituents, dissolved gases, nutrients, and organic matter in seawater.
iii. **CLO 3:** Understand chemical processes in the ocean, radioactivity, and the extraction of useful substances from seawater.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	**3**	1	1	2	2	1	**3**	2	2
CLO 2	1	2	**3**	**3**	2	2	1	**3**	2	2
CLO 3	1	2	**3**	2	2	2	1	**3**	**3**	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Introduction to Chemical Oceanography: History of Chemical Oceanography, Scope, Physical characteristics of oceans.	Week-1	Lecture, Discussion	Class Test/Quiz-1	CLO 1
2	Properties of Seawater: Physical properties of water, Density, Osmotic pressure, The vapor phase, Isotopes of hydrogen and oxygen, Clathrate compounds, Seawater and river water, Comparison of seawater with other natural waters.	Week-2,3	Lecture, Discussion, Presentation	Brain-storming and performance	CLO 1
3	Major and Minor Constituents of Seawater: Major constituents of seawater, Concentrations and residence times of major constituents, Trace metals and minor elements, Various patterns of distribution of minor elements, Special cases of Mercury and Iron, Speciation.	Week-4,5	Lecture, Group Discussion	Class Test/Quiz-2	CLO 2

4	Salinity and Conductivity of Seawater: Salinity, Solubility of salts, Constancy of composition, Variations in salinity, Chemical and physical methods for salinity measurement,	Week-6	Interactive discussion, white board illustration	Presentation, interactions	CLO 1, CLO 2
5	**Mid-Term Examination** Relation between conductivity and salinity, Relation between salinity and density.	Week-7	— Interactive discussion, white board illustration	— Presentation, interactions	— CLO 1, CLO 2
6	Dissolved Gases: Simple gas laws, Solubility of gases in water, Sources of dissolved gases, Atmospheric exchange by diffusion, The carbonate system, Alkalinity and control of pH, Some minor gases, Rate of oxygen consumption, Anoxic oxidation, Dissolved gases as tracers, Air-sea interaction.	Week-8,9	Power point presentation, white board illustration	Assignment	CLO 2
7	Nutrients: Phosphorous and its forms of occurrence in seawater, Oceanic distribution of Phosphorous, Phosphorite minerals, Nitrogen and its chemical forms, Nitrogen fixation, Denitrification, Nitrogen cycles, Dissolved organic nitrogen, Silica: forms, occurrence and solubility, Nutrients other than Phosphorous, Nitrogen and Silicon.	Week-10,11	Power point presentation, white board illustration, discussion on assignments	Oral viva, interactions	CLO 2
8	Dissolved and Particulate Organic Compounds in Seawater: Sources of organic matter, Dissolved and Particulate Organic Matter, Kinds of organic compounds in seawater,	Week-12	Power point presentation, white board illustration, discussions on mid-term scripts	Class Test/Quiz-3	CLO 2

	Concentration and age of marine organic matter.				
9	Radioactivity in Seawater: Radioactivity, Radionuclides in seawater, The Uranium series, Carbon-14. Calculation of 14Cactivity.	Week-13	Lecture, Discussion	Group Presentation	CLO 3
10	Chemical Extraction of Useful Substances from the sea: Salt from seawater, Evaporation of seawater, Rock salt, Extraction of metals from seawater, Fresh water from sea.	Week-14	Lecture, independent reading	Class Test/Quiz-4	CLO 3
11	Chemical Features of Indian Ocean and Bay of Bengal.	Week-15	Power point presentation, white board illustration, interactive Q&A	Group discussion for problem solving of all chapters	CLO 3

PART C

14) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5		3	10
Understand		1	5		3	10
Apply	5				2	10
Analyze		1		2	3	15
Evaluate		1		2	2	10
Create		1		1	2	5

PART D

16) Recommended Text(s):

1. Chemical Oceanography, Frank J. Millero; CRC Press, 2013.
2. Chemical Oceanography, Ronald Cohn; Saunders College Publishing/Harcourt Brace, 2012.
3. An Introduction to the Chemistry of the Sea, Michael E. Q. Pilson, 2nd Edition, Cambridge University Press, 2013.
4. Chemical Oceanography and Marine Carbon Cycle, Steven Emerson; 1st edition, Cambridge
University Press; 2008.
5. Marine Chemistry, by Martin; 2nd edition, New York, M. Dekker, 1972.
6. Chemical Oceanography, Riley; 2nd edition, ELSEVIER.
7. Synthesis of Marine Natural Products, Volume 1, Kim Albizati; V.A.; Springer (1992).
8. Terpenoids (Bioorganic Marine Chemistry); Martin; M.R. Agharahimi

Course Title: Chemical Oceanography Lab	
Course Code: OCN 2110	Credit: 1.5

PART A

1) Course Code: OCN 2110

2) Course Title: Chemical oceanography lab

3) Course Type: Core Course

4) Year and Semester: Year 2, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 1.5

7) **Contact Hours:** 42

8) Total Marks: 100

9) Course Summary and Objectives:

A detailed study of qualitative and quantitative analysis was studied to develop basic knowledge about the properties of seawater through experimental works.
Course objectives include –

- To provide basic knowledge of chemical processes in the ocean.
- To introduce students with methods to undertake analysis of sea water properties.
- To be able to determine amount of dissolved substances in sea water.

10) Course Learning Outcomes (CLO)

i. **CLO 1:** Determine Chemical and Biochemical Oxygen Demand in seawater.
ii. **CLO 2:** Determine amount of dissolved salts as carbonates, nitrates, phosphates, silicates etc.
iii. **CLO 3:** Compare between the properties of seawater and pure water.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	3	2	3	2	2	2	1	1	2	2
CLO 2	3	3	3	3	3	3	2	2	2	2
CLO 3	2	2	2	3	3	3	3	3	3	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Measurement of salinity, density, turbidity and pH of seawater	Week-1	Lecture, Discussion Experimental work	Report writing, quiz	CLO 1, CLO 2, CLO 3
2	Determination of chloride from sea water using precipitation titration	Week-2	Lecture, Discussion, Experimental work	Report writing, quiz	CLO 1, CLO 2, CLO 3
3	Determination of Dissolved Oxygen (D.O.) in sea water sample	Week-3	Lecture, Discussion, Experimental work	Report writing, quiz	CLO 1, CLO 2, CLO 3
4	Determination of Biochemical Oxygen Demand (BOD) from sea water	Week-4	Lecture, Discussion, Experimental work	Report writing, quiz	CLO 1, CLO 2, CLO 3
5	Determination of Chemical Oxygen Demand (COD) from sea water	Week-5	Lecture, Discussion, Experimental work	Report writing, quiz	CLO 1, CLO 2, CLO 3
6	Comparison of hardness between sea water and river water	Week-6	Lecture, Discussion, Experimental work	Report writing, quiz	CLO 1, CLO 2, CLO 3
7	Spectroscopic determination of iron (Fe^{2+}) from sea water	Week-7	Lecture, Discussion, Experimental work	Report writing, quiz	CLO 1, CLO 2, CLO 3
8	Determination of phosphate as ammonium magnesium phosphate hexahydrate using gravimetric analysis	Week-8	Lecture, Discussion, Experimental work	Report writing, quiz	CLO 1, CLO 2, CLO 3
9	Analysis (Qualitative and Quantitative) of sea water properties: a. Total dissolved solid b. Halides c. NO_3^- d. NO_2^- e. NH_4^+ f. CO_3^{2-}	Week-9	Lecture, Discussion, Experimental work	Report writing, quiz	CLO 1, CLO 2

14	**Oral Viva and Class test**	Week-10			

PART C

13)Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**				**Semester Final Examination**
	Attend. (10)	**Class Performance (10)**	**Viva/presentation (20)**	**Assign./Lab report (20)**	**Final (40)**
Remember		02	05		05
Understand		02	10	3	05
Apply	**5**	02		2	05
Analyze		02		05	10
Evaluate		02	05	10	05
Create					10

PART D

16) Textbook

1. An Introduction to the Chemistry of the Sea, Michael E. Q. Pilson, 2nd Edition, Cambridge University Press, 2013.
2. Vogel's Textbook of Quantitative Inorganic Analysis, Revised by Bassett & Jeffery; Fourth Edition.
3. Chemical Oceanography, Frank J. Millero; CRC Press, 2013.
4. Seawater: Its Composition, Properties and Behaviour, John Wright and Angela Colling, Second Edition; Butterworth-Heinenmann, 2003.

Course Title: Meteorology	
Course Code: OCN 2111	**Credit: 3.0**

PART A

1) Course Code: OCN 2111

2) Course Title: Meteorology

3) Course Type: FC

4) Year and Semester: Year 2, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course is designed to teach basic meteorology and ocean forecasting techniques. Oceanic processes are very much related to atmosphere. So, it is important to understand different atmospheric processes in order to know about various oceanic responses.

Course objectives include –

- To know about air-mass, atmospheric circulation, fronts.
- To understand the weather types of the world, weather forecasting.
- To understand climatology and related factors.
- To know about the air-ocean interaction.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Learn about various types of weather conditions around the world.

ii. **CLO 2:** Apply the physical foundations of meteorology to solve problems using analytical methods

iii. **CLO 3:** Understand climate and air-ocean interaction.

iv. CLO 4: Explain basic atmospheric phenomena from a physical perspective

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	1	1	1	1	**3**	**3**	2	2	2	1
CLO 2	**3**	1	**3**	1	**3**	2	1	2	2	1
CLO 3	1	1	1	1	**3**	**3**	**3**	2	2	1
CLO 4	1	**3**	1	1	1	1	1	**3**	1	1

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Introduction to meteorology: The causes of weather, Raw materials of weather studies.	Week-1	Lecture, Discussion	Class Interactions	CLO 1
2	Atmosphere structure and Atmospheric processes.	Week-2	Lecture, Discussion	Class Interactions	CLO 1
3	Air-Mass: Properties and types, Clouds as Air-Mass characteristics, Different geographic Air-Masses (Tropic to polar).	Week-3	Lecture, Discussion, Video Presentation	Class performance and interactions	CLO 1, CLO 3
4	Atmospheric Circulation: Pressure and winds, Forces of balance, The Mechanisms of lows and highs, Thermal system, early circulation model	Week-4	Lecture, Group Discussion	Class Test/Quiz-1	CLO 1, CLO 2
5	Fronts and Frontal disturbances: Air Mass boundaries, Active and Inactive Fronts, Warm and Cold Fronts	Week-5	Interactive discussion, white board illustration	Class interactions	CLO 1, CLO 2

6	Weather and weather types: Equatorial, Tropical, Desert, Mediterranean, Temperate and Polar weather. Tropical Monson weather and tropical cyclone.	Week-6	Power point presentation, white board illustration	Assignment	CLO 2, CLO 4
7	The processing of weather information: Weather station devices, weather station at sea, weather information from the satellite.	Week 7	Power point presentation, white board illustration, discussion on assignments	Oral viva, interactions	CLO 2, CLO 4
8	**Mid Term** Weather information from the satellite.	Week-8	- Power point presentation	- Oral viva, interactions	- CLO 2, CLO 4
9	Weather Forecasting: Conventional forecasting methods, Numerical models, Cyclone forecasting and warning system	Week 9	Power point presentation, white board illustration, discussions on mid-term scripts	Sketching the diagrams	CLO 2, CLO 4
10	Weather Charts and Symbol Interpretation: Synoptic Charts, Meteorological Symbols	Week-10	Power point presentation	Interaction	CLO 2, CLO 4
11	Tropical meteorology: data sources (Oceanographic data, Satellite data, weather data, radar data); Pressure and winds; Temperature, water vapour; Clouds and rainfall and etc.	Week-11	Lecture, Discussion		CLO 1
12	Climatology of Bangladesh and adjacent Bay of Bengal: Physical features, seasonality of pressure, temperature, winds, humidity, rainfall, cyclonic storms and depressions, etc.	Week-12	Lecture Discussion	Class Test/Quiz-2	
13	AI/ML applications in climate modeling and weather prediction	Week-13	Lecture, independent reading	Group assignment	CLO 1, CLO 3

14	Ocean and Climate Observation	Week-14	Power point presentation, white board illustration	Group Presentation	CLO 3

PART C

13) Assessment and Evaluation

Bloom's Category	Continuous Internal Evaluation					Semester Final Examination
	Attend. (05)	Class Performance (05)	Class Tests (10)	Assign. (05)	Mid Term (15)	Final (60)
Remember		1	5		3	10
Understand		1	5		3	10
Apply	5				2	10
Analyze		1		2	3	15
Evaluate		1		2	2	10
Create		1		1	2	5

PART D

REFERENCE BOOKS

1. Basic Meteorology: An Introduction to the Science. L. L. Moses, Tomikel, Allegheny Press (1981), ISBN: 091004203.
2. Everyday Meteorology, by A. Miller, M. Parry, Hutchinson of London (1975), ISBN: 0091219108.
3. Weather: An Introductory Meteorology, by W. G. Kendrew, Oxford University Press (1943).

Detail Syllabus Fourth Semester
(Year-2, Semester-2)

Course Title: Sedimentology and Stratigraphy	
Course Code: OCN 2201	**Credit: 3**

PART A

1) Course Code: OCN 2201

2) Course Title: Sedimentology and Stratigraphy

3) Course Type: Core Course

4) Year and Semester: Year 2, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course is designed to get knowledge about sediments and sedimentation. The Bay of Bengal receives a huge quantity of sediments carried by the river system. The understanding of sediment, sedimentary rocks, sedimentary processes, and sediment dynamics are important in the overall study of the ocean.

Course objectives include –

- To learn about different types of sedimentary rocks.
- To learn about sedimentary processes
- To learn about sediment transport and depositional environment.
- To understand sediments and sedimentation for blue resource development.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Understand different types of sedimentary rocks that form in marine environments and their resource potentialities.
ii. **CLO 2:** Learn the process of sediment transportation, structure, texture, and different environments of deposition.
iii. **CLO 3:** Know different Bed forms.
iv. CLO 4: Acquire knowledge of the relationship between sedimentation and tectonic processes.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	1	1	1	1	3	3	2	2	2	1
CLO 2	3	1	3	1	3	2	1	2	2	1
CLO 3	1	1	1	1	3	3	3	2	2	1
CLO 4	1	3	1	1	1	1	1	3	1	1

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Introduction and scope	Week 1	Lecture, Discussion		CLO 1
2	Physical principles of sedimentation. Types of sediments in the ocean including their origin and composition. The Sediment Factory: From Source to Sink	Week 2-4	Lecture, Discussion, Video Presentation	Class performance and interactions	CLO 1, CLO 3
3	Transport and deposition of siliciclastic sediment: fluid flow, Particle transport by fluids. Particle transport by sediment gravity flows.	Week 5	Lecture, Group Discussion	Assignment	CLO 1, CLO 2
4	Physical Properties of Sedimentary Rocks: Sediment texture, grain-size analysis weathering processes	Week 6-7	Interactive discussion, whiteboard illustration	Class Test/Quiz-1	CLO 1, CLO 2
5	**Mid-Term Examination** Erosion and sedimentation, sorting, and grain size change, modes of sediment transport	Week-8	- Interactive discussion, whiteboard illustration	- Class performance and interactions	- CLO 1, CLO 2
6	Sedimentary Structures	Week 9-10	Power point presentation,	Class performance	

			white board illustration	and interactions	
7	Composition, Classification, and diagenesis of sedimentary rocks: Silici-Clastic sedimentary rocks Clastic sedimentary systems.	Week 11-12	Power point presentation, white board illustration	Assignment	CLO 2, CLO 4
8	Depositional environments: marginal-sea environment and oceanic environment (silisiclastic carbonate and evaporite). Chemical/biochemical and carbonaceous sedimentary rocks (evaporites, chert, iron-stone, phosphorite, coal, oil-shale).	Week 13-14	Power point presentation, white board illustration, discussions on mid-term scripts	Sketching the diagrams	CLO 2, CLO 4
9	Chemical sedimentary rocks - Carbonate rocks- the water-carbonate system, carbonate depositional environments	Week 15	Lecture, independent reading	Group assignment, Presentation, interactions	CLO 1, CLO 3
10	Stratigraphy and Basin Analysis: Lithostratigraphy, biostratigraphy, chrono-stratigraphy, Basic Stratigraphic Principles Basin Formation: Tectonic processes and sedimentation. Stratigraphy of Bangladesh.	Week 16	Power point presentation, white board illustration, discussions on mid-term scripts	Sketching the diagrams	CLO 1, CLO 3

PART C

13) **Assessment and Evaluation**

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5			10
Understand		1	5		5	10
Apply	5	1			5	15
Analyze		1		3	5	15
Evaluate		1		1		10
Create				1		

PART D

16) Reference Books:

1. Principles of Sedimentology and Stratigraphy by Sam Boggs Jr. ISBN-13: 9780321643186
2. Sedimentology: process and product, by M.R. Leeder, Springer, ISBN: 978-94-009-5986-6.
3. Sedimentology and petroleum geology, by Knut Bjorlykke, Springer, ISBN: 978-3-540-17691-6.
4. Sedimentology and stratigraphy, by Gary Nichols, Wiley-Blackwell, ISBN: 1405135921.
5. Sedimentology and sedimentary basins: from turbulence to tectonics, by Mike R Leeder, Wiley-Blackwell, ISBN: 1405177837.
6. Global sedimentology of the ocean: an interplay between geodynamics and paleo-environment, by Christian M Robert, Elsevier Science, ISBN: 0444518177.
7. Reading, H. G. Sedimentary Environments: Processes, Facies and Stratigraphy. Blackwell Science. 1996, 688 p.
8. Tucker, M. E., and Wright, V. P. Carbonate Sedimentology. Blackwell Scientific Publication, 1990, 482 p.
9. Global sedimentology of the ocean: an interplay between geodynamics and paleo-environment, by Christian M Robert, Elsevier Science, ISBN: 0444518177.
10. Sedimentary basins: evolution, facies and sediment budget, by Gerhard Einsele, Springer, ISBN: 3540544496.

Course Title: Sedimentology and Stratigraphy Lab	
Course Code: OCN 2202	Credit: 1.5

PART A

1) Course Code: OCN 2202

2) Course Title: Sedimentology and Stratigraphy Lab

3) Course Type: SKD

4) Year and Semester: Year 2, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 1.5

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course provides practical training to the students to understand physical processes involved in the erosion, transport and deposition of sediments. The knowledge of sedimentology is important for students in case of studying ocean floor, mineral resource exploitation etc.

Course objectives include –

- To develop the knowledge of sediment movement.
- To do the observation of various bed forms.
- To learn the measurement techniques of sediment movement.
- To learn different field observation techniques related to sedimentology.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Acquire knowledge on sedimentary environment.

ii. **CLO 2:** Know the processes involved and the characteristics.

iii. **CLO 3:** Learn the interpretation of sedimentary rock layers.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	1	1	1	1	**3**	**3**	2	2	2	1
CLO 2	**3**	1	**3**	1	**3**	2	1	2	2	1
CLO 3	1	1	1	1	**3**	**3**	**3**	2	2	1
CLO 4	1	**3**	1	1	1	1	1	**3**	1	1

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Introduction and scope	Week-1	Lecture, Discussion	Assignment	CLO 1
2	Visual sediment analysis; Grain size analysis by sieving; pipette analysis; Sedimentary rock types identification in hand specimen; Use of plane polarized microscope;	Week-2-5	Lecture, Discussion, Video Presentation	Class performance and interactions	CLO 1, CLO 3
3	Thin section preparation techniques; Thin section analysis; Textural analysis; Identification of sedimentary structures;	Week-6-7	Lecture, Group Discussion	Class Test/Quiz-1	CLO 1, CLO 2
4	Graphical presentation of particle size distribution; Calculation of median, mean, sorting, skewness, kurtosis; Plotting and interpreting histograms and frequency curves;	Week-8-10	Interactive discussion, white board illustration	Presentation, interactions	CLO 1, CLO 2
5	Heavy mineral analysis (separation techniques, provenance); Facies analysis	Week-11-12	Power point presentation, white board illustration	Assignment	CLO 2, CLO 4
6	Sediment movement: Initiation of movement, justification of erosion and stable condition.	Week-13	Power point presentation, white board illustration, discussion on assignments	Oral viva	CLO 2, CLO 4
7	Field observation: Erosion-deposition characterization, Rock Characterization	Week-14	Power point presentation, white board illustration,	Sketching the diagrams	CLO 2, CLO 4

PART C

13) Assessment and Evaluation

Bloom's Category	Continuous Internal Evaluation					Semester Final Examination
	Attend. (10)	Class Performance (10)	Class Tests (10)	Assign. (20)	viva (10)	Final (40)
Remember		2			2	5
Understand		2	5	5	2	5
Apply	**5**	2	5	5	2	10
Analyze		2		5	2	10
Evaluate		1		2	1	5
Create		1		3	1	5

PART D

16) Reference Books:

11. Principles of Sedimentology and Stratigraphy by Sam Boggs Jr. ISBN-13: 9780321643186
12. Sedimentology: process and product, by M.R. Leeder, Springer, ISBN: 978-94-009-5986-6.
13. Sedimentology and petroleum geology, by Knut Bjorlykke, Springer, ISBN: 978-3-540-17691-6.
14. Sedimentology and stratigraphy, by Gary Nichols, Wiley-Blackwell, ISBN: 1405135921.
15. Sedimentology and sedimentary basins: from turbulence to tectonics, by Mike R Leeder, Wiley-Blackwell, ISBN: 1405177837.
16. Global sedimentology of the ocean: an interplay between geodynamics and paleo-environment, by Christian M Robert, Elsevier Science, ISBN: 0444518177.
17. Reading, H. G. Sedimentary Environments: Processes, Facies and Stratigraphy. Blackwell Science. 1996, 688 p.
18. Tucker, M. E., and Wright, V. P. Carbonate Sedimentology. Blackwell Scientific Publication, 1990, 482 p.
19. Global sedimentology of the ocean: an interplay between geodynamics and paleo-environment, by Christian M Robert, Elsevier Science, ISBN: 0444518177.
20. Sedimentary basins: evolution, facies and sediment budget, by Gerhard Einsele, Springer, ISBN: 3540544496.

Course Title: Fisheries Oceanography	
Course Code: OCN 2203	**Credit: 3.0**

PART A

1) Course Code: OCN 2203

2) Course Title: Fisheries Oceanography

3) Course Type: CC

4) Year and Semester: Year 2, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course is designed to get the knowledge about marine fisheries. Marine fishes have characteristics and adaptation different from fresh water fishes. Marine fishes and shellfish are very important resources.
Course objectives include –

- To learn about the classification of marine fishes and shellfish.
- To know the monitoring, forecasting and different technology related to fisheries.
- To understand the fisheries ecosystem and climatic variability.
- To learn about the fishing grounds of Bay of Bengal.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Learn about diversity of marine fisheries.
ii. **CLO 2:** Understand the relation between fish ecosystem and climatic variability.
iii. **CLO 3:** Know about the technologies of fish monitoring, forecasting and so on.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / **CLO**	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	1	1	1	1	**3**	**3**	2	**3**	2	1
CLO 2	1	1	**3**	1	2	**3**	2	**3**	2	1
CLO 3	1	1	1	1	2	**3**	2	**3**	2	1

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Introduction and scope	Week-1	Lecture, Discussion	Class performance and interactions	CLO 1
2	Systematics of fish	Week-2	Lecture, Discussion, Video Presentation	Assignment	CLO 1, CLO 2
3	Systematics of shellfish	Week-3	Lecture, Group Discussion	Class Test/Quiz-1	CLO 1, CLO 2
4	Life history, reproduction, food	Week-4	Interactive discussion, white board illustration	Presentation, interactions	CLO 1, CLO 2
5	Fishing grounds of the Bay of Bengal	Week-5	Power point presentation, white board illustration	Assignment	CLO 2, CLO 3
6	**Fishing crafts**	Week-6	Power point presentation, white board illustration, discussion on assignments	Oral viva, interactions	CLO 2, CLO 3
7	**Mid-Term Examination** Feeding mechanisms of marine fish	Week-7	- Power point presentation, white board illustration	- Oral viva, interactions	- CLO 2, CLO 3
8	Fishing gears used in the Bay of Bengal	Week-8	Power point presentation, white board illustration, discussions on mid-term scripts	Sketching the diagrams	CLO 2, CLO 3
9	Fish population and their dynamics	Week-9	Lecture, Discussion	Class Test/Quiz-2	CLO 2
10	Fish Forecasting Techniques: Detection of fish schools and oceanic fronts; ecological selectivity; use of satellite data and	Week-10	Lecture, independent reading	Group assignment	CLO 3

	tools for potential fishing zone (PFZ) identification.				
11	Fisheries monitoring and control: Concepts of common property resources, use of GPS data loggers, and implementation of fishing pauses or seasonal bans	Week-11	Power point presentation, white board illustration, interactive Q&A	Brain-storming and performance	CLO 3
12	Fishery technology & products: Marine fish preservation and processing techniques in Bangladesh; utilization of fishery by-products; export potential of marine products	Week-12	Power point presentation, white board illustration	Class Test/Quiz-3	CLO 3
13	Climate variability and fisheries ecosystems	Week-13	Power point presentation, white board illustration, independent reading	Assignment	CLO 3
14	Fisheries Governance & Policy: FAO Code of Conduct for Responsible Fisheries; overview of the Marine Fisheries Ordinance and regulations in Bangladesh.	Week-14	Power point presentation, white board illustration	Group Presentation	CLO 3

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5			10
Understand		1	5		5	10
Apply		1			5	15
Analyze		1		3	5	15
Evaluate		1		2		10
Create						

PART D

14) Textbook:

a) Fisheries Biology, Assessment and Management, by M. King, Wiley-Blackwell, ISBN: 140515831X.

15) Reference Books:

1. An Introduction to the Practice of Fishery Science, W. F. Royce, Academic Press (1996), ISBN: 012600952X.
2. Bangladesh Fisheries, M. Shafi.

Course Title: Fisheries Oceanography Lab	
Course Code: OCN 2204	**Credit: 1.5**

PART A

1) Course Code: OCN 2204

2) Course Title: Fisheries Oceanography Lab

3) Course Type: SKD

4) Year and Semester: Year 2, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 1.5

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course provides practical knowledge on fish and other shellfish. It is important to know about fisheries because they have a high commercial value and very important marine resources. Course objectives include –

- To learn the characteristics and identification techniques of marine fishes.
- To know about the internal and external processes of fish.
- To learn about fishing processes and overfishing.
- To understand growth rate, mortality and reproduction of fisheries.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Identify fishes and shellfishes.
ii. **CLO 2:** Determine age, maturity, growth rate, mortality etc.
iii. **CLO 3:** Understand overfishing and commercial fisheries.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / **CLO**	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	1	1	1	1	3	3	2	3	3	1
CLO 2	1	2	3	3	2	2	1	2	2	1
CLO 3	1	1	1	1	2	2	1	2	3	1

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Introduction and scope	Week-1	Lecture, Discussion	Class performance and interactions	CLO 1
2	Identification of crustaceans	Week-2	Lecture, Discussion, Video Presentation	Assignment	CLO 1, CLO 2
3	Identification of mollusks	Week-3	Lecture, Group Discussion	Class Test/Quiz-1	CLO 1, CLO 2
4	Biometric study of fishes	Week-4	Interactive discussion, white board illustration	Presentation, interactions	CLO 1, CLO 2
5	Biometric study of prawns.	Week-5	Power point presentation, white board illustration	Assignment	CLO 2, CLO 3
6	Gut content analysis	Week-6	Power point presentation, white board illustration, discussion on assignments	Oral viva, interactions	CLO 2, CLO 3
7	**Class Test**	Week-7			
8	Age determination	Week-8	Power point presentation, white board illustration, discussions on mid-term scripts	Sketching the diagrams	CLO 2, CLO 3
9	Maturity determination of reproductive organs	Week-9	Lecture, Discussion	Class Test/Quiz-2	CLO 2
10	Observation of different types of crafts	Week-10	Lecture, independent reading	Group assignment	CLO 2, CLO 3
11	Observation of different types of gears	Week-11	Power point presentation, white board illustration, interactive Q&A	Brain-storming and performance	CLO 2, CLO 3
12	Determination of growth rates	Week-12	Power point presentation, white board illustration	Class Test/Quiz-3	CLO 2, CLO 3

13	Determination of mortality and overfishing.	Week-13	Power point presentation, white board illustration, independent reading	Assignment	CLO 3
14	Detection of fishing and no fishing zone, AI in fisheries stock prediction	Week-14	Power point presentation, white board illustration	Group Presentation	CLO 3

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (10)	**Class Performance (10)**	**Class Tests (10)**	**Assign. (20)**	**viva (10)**	**Final (40)**
Remember		2			2	5
Understand		2	5	5	2	5
Apply		2	5	5	2	10
Analyze		2		5	2	10
Evaluate		1		2	1	5
Create		1		3	1	5

(Weightage: 3-High, 2-Medium, 1-Low)

PART D

14) Textbook:

a) Fisheries Biology, Assessment and Management, by M. King, Wiley-Blackwell, ISBN: 140515831X.

15) Reference Books:

3. An Introduction to the Practice of Fishery Science, W. F. Royce, Academic Press (1996), ISBN: 012600952X.
4. Bangladesh Fisheries, M. Shafi.

Course Title: Marine Microbiology	
Course Code: OCN 2205	Credit: 3.0

PART A

1) Course Code: OCN 2205

2) Course Title: Marine Microbiology

3) Course Type: CC

4) Year and Semester: Year 2, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course is designed to get the knowledge about the marine microorganisms. Microorganisms have a crucial role in various biogeochemical cycles and also in ecology. Course objectives include –

- To get acquainted with marine microorganisms.
- To understand general concept and historical development of marine microbiology.
- To learn about microbial ecology and the role of microorganisms.
- To understand microbial pollution and the relationship of microorganisms with other organisms.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Understand the diversity and role of marine microorganisms.
ii. **CLO 2:** Learn different microbial processes of environmental and geochemical significance.
iii. **CLO 3:** Know relationship and different between marine and terrestrial microorganisms.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	1	1	1	1	3	3	3	2	2	1
CLO 2	1	1	1	1	3	3	2	2	2	1
CLO 3	1	1	1	1	3	3	3	2	2	1

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	General concepts and historical development of Marine Microbiology.	Week-1	Lecture, Discussion	Assignment	CLO 1
2	Morphology, structure Systematic study of bacteria, virus, yeasts and fungi.	Week-2	Lecture, Discussion, Video Presentation	Class performance and interactions	CLO 1, CLO 2
3	Marine microbial ecology: effects of the environment upon microbes - Temperature, Pressure, Radiation, Moisture, Hydrogen ion concentration, Oxidation and reduction potentials, Salinity and Gases.	Week-3	Lecture, Group Discussion	Class Test/Quiz-1	CLO 1, CLO 2
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.	Week-4	Interactive discussion, white board illustration	Presentation, interactions	CLO 1, CLO 2
5	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.	Week-5	Power point presentation, white board illustration	Assignment	CLO 2, CLO 3
6	Physiology of Microorganisms: Respiration, Nutrition, Fermentation, Product on of	Week-6	Power point presentation, white board illustration,	Oral viva, interactions	CLO 2, CLO 3

	enzymes-their nature& enzymatic reactions,		discussion on assignments		
7	**Mid-Term Examination** Staining properties of bacterial cell, Bacterial spores, Reproduction and life cycle.	Week-7	- Power point presentation, white board illustration	- Assignment	CLO 2, CLO 3
8	Role of Microorganisms in the transformation of different matters, oils and gases in the sea and associated nutrient cycle, carbon cycle and sulfur cycle.	Week-8	Power point presentation, white board illustration, discussions on mid-term scripts	Sketching the diagrams	CLO 2, CLO 3
9	Relationships and differences between marine and terrestrial microorganisms; Deep sea and hydrothermal vents, microbial toxins, food poisoning.	Week-9	Lecture, Discussion	Class Test/Quiz-2	CLO 1
10	Relationships and differences between marine and terrestrial microorganisms; Deep sea and hydrothermal vents, microbial toxins, food poisoning.	Week-10	Lecture, independent reading	Group assignment	CLO 1, CLO 3
11	Microbial pollution of the marine environment (soil, water and live organisms).	Week-11	Power point presentation, white board illustration, interactive Q&A	Brain-storming and performance	CLO 3
12	Microbial pollution of the marine environment (soil, water and live organisms).	Week-12	Power point presentation, white board illustration	Class Test/Quiz-3	CLO 1, CLO 3
13	Ocean acidification and rapid changes in ocean chemistry.	Week-13	Power point presentation, white board illustration, independent reading	Assignment	CLO 1, CLO 3

14	Economic importance and application of micro-organisms in Oceanography.	Week-14	Power point presentation, white board illustration	Group Presentation	CLO 3

PART C

13) Assessment and Evaluation

Bloom's Category	Continuous Internal Evaluation					Semester Final Examination
	Attend. (05)	Class Performance (05)	Class Tests (10)	Assign. (05)	Mid Term (15)	Final (60)
Remember		1	5		3	10
Understand		1	5		3	10
Apply	5				2	10
Analyze		1		2	3	15
Evaluate		1		2	2	10
Create		1		1	2	5

PART D

14) Textbook:

a) Marine microbial ecology, by E. J. F. Wood (1965).
b) Microbiology, by Eugene Nester et al, McGraw-Hill Science/Engineering/Math, ISBN: 0077250419.

15) Reference Books:

a) The microbial world, by Stanier et al, 1970.
b) Microbial interactions, edited by JL Reissig, Springer US (1977), ISBN: 978-1-4615-9700-1.
c) Microbiology, by Michael et al, 1986.
d) Marine Microbiology, by B. Austin, CUP Archive (1988), ISBN: 0521311306.

Course Title: Marine Microbiology Lab	
Course Code: OCN 2206	Credit: 1.5

PART A

1) Course Code: OCN 2206

2) Course Title: Marine Microbiology Lab

3) Course Type: SKD

4) Year and Semester: Year 2, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 1.5

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course provides practical training to learn about various microorganisms and microbial communities. Microorganisms and microbial activities are important part in ocean biogeochemical cycle. To provide detailed information on the most up to date methods for the study of microbial communities through analysis of microbial datasets. Course objectives include –

- To do qualitative and quantitative study of microorganisms.
- To do the growth study of microorganisms and the factors affecting their growth.
- To learn about culture techniques of marine microorganisms.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Identify various microorganisms.
ii. **CLO 2:** Analyse microbial dataset.
iii. **CLO 3:** Do the growth study of microorganisms.
iv. CLO 4: Culture marine microorganisms.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / **CLO**	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	1	1	1	1	**3**	**3**	**3**	2	2	1
CLO 2	1	1	1	1	**3**	**3**	2	2	2	1
CLO 3	1	1	1	1	**3**	**3**	**3**	2	2	1
CLO 4	1	1	1	1	**3**	2	2	**3**	2	1

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Perpetration of different types of culture media.	Week-1	Lecture, Discussion	Assignment	CLO 1
2	Perpetration of different types of culture media.	Week-2	Lecture, Discussion, Video Presentation	Class performance and interactions	CLO 1, CLO 3
3	Techniques of isolation and identification of marine micro-organisms.	Week-3	Lecture, Group Discussion	Class Test/Quiz-1	CLO 1, CLO 2
4	Techniques of isolation and identification of marine micro-organisms.	Week-4	Interactive discussion, white board illustration	Presentation, interactions	CLO 1, CLO 2
5	Techniques of isolation and identification of marine micro-organisms.	Week-5	Power point presentation, white board illustration	Assignment	CLO 2, CLO 4
6	Quantitative and quantitative study of micro-organisms from water, Soil, Fish, Shrimp, and other fisheries organisms.	Week-6	Power point presentation, white board illustration, discussion on assignments	Oral viva, interactions	CLO 2, CLO 4
7	**Class Test** Quantitative and quantitative study of micro-organisms from water, Soil, Fish, Shrimp, and other fisheries organisms.	Week-7	- Power point presentation, white board illustration, discussion on assignments	- Oral viva, interactions	- CLO 2, CLO 4
8	Quantitative and quantitative study of micro-organisms from water, Soil, Fish,	Week-8	Power point presentation, white board illustration,	Sketching the diagrams	CLO 2, CLO 4

	Shrimp, and other fisheries organisms.		discussions on mid-term scripts		
9	Growth study: factors affecting the growth of micro-organisms, Temperature, Salinity, Osmotic pressure, pH.	Week-9	Lecture, Discussion	Class Test/Quiz-2	CLO 1
10	Growth study: factors affecting the growth of micro-organisms, Temperature, Salinity, Osmotic pressure, pH.	Week-10	Lecture, independent reading	Group assignment	CLO 1, CLO 3
11	Growth study: factors affecting the growth of micro-organisms, Temperature, Salinity, Osmotic pressure, pH.	Week-11	Power point presentation, white board illustration, interactive Q&A	Brain-storming and performance	CLO 3
12	Growth study: factors affecting the growth of micro-organisms, Temperature, Salinity, Osmotic pressure, pH.	Week-12	Power point presentation, white board illustration	Class Test/Quiz-3	CLO 1, CLO 3
13	Culture techniques of marine micro-organisms.	Week-13	Power point presentation, white board illustration, independent reading	Assignment	CLO 1, CLO 3
14	Culture techniques of marine micro-organisms.	Week-14	Power point presentation, white board illustration	Group Presentation	CLO 3

PART C

13) Assessment and Evaluation

Bloom's Category	Continuous Internal Evaluation					Semester Final Examination
	Attend. (10)	Class Performance (10)	Class Tests (10)	Assign. (20)	viva (10)	Final (40)
Remember		2			2	5
Understand		2	5	5	2	5
Apply	**5**	2	5	5	2	10
Analyze		2		5	2	10
Evaluate		1		2	1	5
Create		1		3	1	5

PART D

14) Textbook:

a) Marine microbial ecology, by E. J. F. Wood (1965).
b) Microbiology, by Eugene Nester et al, McGraw-Hill Science/Engineering/Math, ISBN: 0077250419.

15) Reference Books:

a) The microbial world, by Stanier et al, 1970.
b) Microbial interactions, edited by JL Reissig, Springer US (1977), ISBN: 978-1-4615-9700-1.
c) Microbiology, by Michael et al, 1986.
d) Marine Microbiology, by B. Austin, CUP Archive (1988), ISBN: 0521311306.

Course Title: Foundations Of Data Science	
Course Code: OCN 2207	Credit: 3.0

PART A

1) Course Code: OCN 2207

2) Course Title: Foundations of Data Science

3) Course Type: FC

4) Year and Semester: Year 2, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course provides a foundational understanding of data science principles, with an emphasis on applications relevant to Earth and Ocean Sciences. The course aims to equip students with skills in data collection, cleaning, analysis, visualization, and basic machine learning techniques. It will prepare students for advanced studies and careers in data-intensive scientific fields by introducing programming concepts, statistical techniques, and machine learning models. The focus is on applying these methods to environmental and oceanographic datasets.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Understand the fundamental concepts and workflow of data science, including data collection, cleaning, exploration, modeling, and communication.
ii. **CLO 2:** Apply programming skills (e.g., Python) for data manipulation, analysis, and visualization, focusing on Earth and Ocean Science data.
iii. **CLO 3:** Perform exploratory data analysis and apply basic statistical concepts to interpret scientific data.
iv. CLO 4: Implement fundamental machine learning algorithms for predictive modeling using oceanographic and environmental datasets.
v. CLO 5: Critically evaluate data sources and interpret analytical results, considering the ethical implications of data science.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	3	3	3	3	3	3	2	2	3	2
CLO 2	3	3	3	2	2	2	3	2	3	2
CLO 3	3	3	2	3	2	2	3	2	3	2
CLO 4	3	2	3	3	2	2	3	2	3	2
CLO 5	3	3	3	2	3	2	2	3	3	3

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	**Introduction to Data Science:** Overview of data science, its scope, and interdisciplinary nature. The data science workflow: data collection, cleaning, exploration, modeling, and communication. Role of data science in Earth and Ocean Sciences. Introduction to tools and technologies like Python, R, and Jupyter Notebooks.	Week-1	Lecture, Discussion	Assignment on the importance and workflow of data science	CLO 1
2	**Programming Fundamentals for Data Science (Python):** Introduction to Python programming, covering syntax, data types, control structures, and functions..	Week-2	Lecture, Hands-on Coding	Quiz on Python basics and usage of data structures	CLO 2
3	**Data Collection and Cleaning:** Overview of environmental and oceanographic data sources. Data acquisition methods: APIs, web scraping, and databases. Techniques for handling missing data, including imputation and deletion. Data transformation, normalization, and merging datasets.	Week-3	Lecture, Practical Exercises	Lab report on data cleaning and integration	CLO 2, CLO 3
4	**Scientific Visualization:** Principles of effective scientific visualization. 2D and 3D plotting with Matplotlib and other libraries. Visualizing scalar and vector fields, Creating animations and interactive plots. Visualization of	Week-4-6	Hands-on Coding, Visualization	Lab work on creating visualizations for scientific data	CLO 4

	oceanographic and atmospheric data.				
5	**Mid-term Examination** **Exploratory Data Analysis (EDA) and Visualization:** Descriptive statistics: Measures of central tendency, dispersion, and data shape. Data visualization using Matplotlib and Seaborn for histograms, scatter plots, box plots, and heatmaps. Visualization of time series and geospatial data. Irregular sampling, detrending, filtering, FFT/spectral density, seasonal decomposition, ARIMA basics.	- Week-7-9	- Hands-on Coding, Data Analysis	- Lab work on performing EDA and creating visualizations	- CLO 3
6	**Statistical Foundations for Data Science:** Introduction to basic statistical concepts such as probability distributions (Normal, Binomial, Poisson). Sampling and sampling distributions. Hypothesis testing (Z-tests, T-tests, Chi-squared tests). Regression analysis basics.	Week-10-11	Lecture, Group Discussion	Class test on statistical concepts and their applications	CLO 3, CLO 5
6	**Introduction to Machine Learning:** Overview of supervised and unsupervised learning. Introduction to regression models (Multiple Linear Regression), classification models (K-Nearest Neighbors, Logistic Regression). Evaluation metrics like R-squared, accuracy, precision, and recall. PCA, clustering (k-means, hierarchical), regularization (Ridge/Lasso), decision trees and random forests (basic intuition), cross-	Week-11-13	Lecture, Case Studies	Project work on applying machine learning models to real-world datasets	CLO 4

	validation, hyperparameter search.				
7	**Data Ethics and Privacy:** Ethical considerations in data collection and analysis. Data privacy and security. Bias in data and algorithms. Responsible data science practices, focusing on transparency and fairness in data analysis.	Week-14	Lecture, Discussion	Research paper on data ethics and its importance in data science	CLO 5

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	2		2	10
Understand		1	2	1	3	10
Apply	**5**	1	2	1	2	15
Analyze		1	2	1	3	15
Evaluate		1		1	2	5
Create			2	1	3	5

PART D

14) Reference Books:

1. McKinney, W. (2017). Python for Data Analysis. O'Reilly Media.
2. Géron, A. (2019). Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow. O'Reilly Media.
3. James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An Introduction to Statistical Learning with Applications in R. Springer.

Course Title: Foundations Of Data Science Lab	
Course Code: OCN 2208	**Credit: 1.5**

PART A

1) Course Code: OCN 2208

2) Course Title: Foundations of Data Science Lab

3) Course Type: CC

4) Year and Semester: Year 2, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 1.5

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This lab course provides practical experience with the fundamental methods and tools of data science, with an emphasis on applications in Earth and Ocean Sciences. Students will develop hands-on skills in data collection, cleaning, processing, exploration, visualization, and elementary machine learning using Python and professional scientific software. The course aims to prepare students to efficiently work with environmental data and support data-driven research.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Demonstrate proficiency in core data science software tools (Python, Jupyter Notebook).
ii. **CLO 2:** Apply foundational techniques for collecting, cleaning, and manipulating real-world datasets.
iii. **CLO 3:** Perform exploratory data analysis and visualization using Python libraries.
iv. CLO 4: Implement and evaluate basic machine learning algorithms for simple prediction and classification tasks.
v. **CLO 5:** Present, interpret, and document analytical results in a scientific and reproducible way

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	3	3	2	2	3	3	2	2	3	2
CLO 2	3	2	3	2	2	2	3	2	3	2
CLO 3	3	3	2	3	2	2	3	2	2	2
CLO 4	3	2	3	3	2	2	3	2	2	2
CLO 5	3	3	2	2	3	2	2	3	3	3

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Allocation	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Introduction to Python, Jupyter Notebook, and basic data structures	Week 1-2	Hands-on demo, group practice	Assignment on notebook setup and data structures	CLO 1
2	Data input/output and acquisition: Importing files (CSV/Excel), accessing public datasets, web scraping basics	Week 2-3	Guided lab, live coding	Exercise on acquiring and importing environmental data	CLO 2
3	Data cleaning and preprocessing: Handling missing data, type conversion, normalization	Week 4-5	Practical, problem solving	Lab report on cleaning and transforming real datasets	CLO 2
4	Exploratory Data Analysis (EDA): Descriptive stats, distributions, outlier identification	Week 6-7	Workshop, discussion	Lab work/report on EDA and summary statistics	CLO 3

Sl. No.	Course Contents	Time Allocation	Teaching Strategies	Assessment Strategies	Alignment with CLOs
5	Data visualization: Building basic plots (histograms, scatter, line, box), using Matplotlib/Seaborn	Week 8-9	Coding exercises	Assignment on generating and interpreting visualizations	CLO 3
6	Introduction to regression and classification: Linear regression, KNN	Week 10-11	Hands-on lab, demo	Exercise on applying models to environmental data	CLO 4
7	Model evaluation: Train/test split, accuracy, visualization of results	Week 12	Live coding, Q&A	Assignment on model evaluation metrics, prediction plots	CLO 4
8	Mini-project: Group analysis of a real environmental/oceanographic dataset	Week 13	Project-based, peer review	Group project report and presentation	CLO 5
9	Scientific reporting: Documenting code, exporting results, reproducibility	Week 14	Writing, feedback session	Notebook/report submission, discussion	CLO 5

PART C

13) Assessment and Evaluation

Bloom's Category	Semester Final Examination				
	Attend. (10)	Class Performance (10)	Assign. / Report (20)	Present. / Viva (20)	Final (40)
Remember		2		4	5
Understand		2	4	6	5
Apply	5	2	4	2	10
Analyze		2	4	3	10
Evaluate		2	4	2	5
Create			4	3	5

PART D

14) Reference Books:

- Géron, A. (2019). *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*. O'Reilly Media.
- James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An Introduction to Statistical Learning with Applications in R*. Springer.
- VanderPlas, J. (2018). *Python Data Science Handbook*. O'Reilly Media.

Course Title: Viva-voce	
Course Code: OCN 2209	**Credit: 1.5**

PART-A

1) **Course Code:** OCN 2209

2) **Course Title:** Viva-Voce

3) **Course Type:** FC

4) **Year and Semester:** Year 1, Semester 2

5) **Prerequisite (if any):** N/A

6) **Credit Value:** 1.5

7) **Contact Hours:** N/A

8) **Total Marks:** 100

Viva voce will be conducted towards the end of the academic year which will be covering the complete syllabus. This will assess the student's knowledge and understanding during the course of their graduate programme. In doing so, the main objective of this course is to prepare the students to face interview both at the academic and the professional arenas.

9) **Course Objectives:**

The primary aim of the course is to develop students' confidence in oral assessments and to evaluate the conceptual understanding gained during their first year of undergraduate education.

10) **Course Learning Outcomes (CLOs):**

Upon successful completion of the course the students will be able to:

i. CLO1: To describe and explain their understanding of the theoretical and practical fundamental courses.
ii. CLO2: Get prepared to face the interview both at the academic and the professional arenas.

11) **Mapping of CLOs with Program Learning Outcomes (PLOs):**

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	3	2	3	3	2	2	2	3	2	2
CLO 2	2	2	2	2	2	2	2	3	2	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) **Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques**

Course Contents	**Teaching Strategies**	**Assessment Strategies**	**Alignment with CLOs**
1. Comprehensive assessment of all courses offered in the second year, spanning both the first and second semesters.	Viva	Oral Exam	CLO 1, CLO 2

Course Title: Field Work II: Observational Techniques in Oceanography	
Course Code: OCN 2210	**Credit: 1.5**

PART A

1) **Course Code:** OCN 2210

2) **Course Title:** Observational Techniques in Oceanography

3) **Course Type:** SKD

4) **Prerequisite (if any):** N/A

5) **Credit Value:** 1.5

6) **Contact Hours:** 42

7) **Total Marks:** 100

8) **Course Summary and Objectives:**

This course provides students with foundational skills in geological oceanography and mapping field techniques through a combination of classroom preparation and an immersive five-day fieldwork program in hill tract and sea beach of Coxsbazar. The course focuses on developing practical skills for geological mapping, sedimentary logging, structural measurements, and field interpretation. Emphasis is placed on understanding and documenting large-scale geological features such as folds, faults, and unconformities, as well as the identification and analysis of stratigraphic units, sedimentary structures, sedimentary rocks, and coastal morphology features. Students will gain hands-on experience in measuring bed attitudes, interpreting three-dimensional geological structures, and reconstructing the geological history of the area. Students are trained to collect and synthesize field data, construct lithological columns, correlate stratigraphic sections, and produce geological maps and reports based on field observations. The course integrates hands-on exercises, field lectures, and laboratory work to reinforce geological reasoning and reporting.

Learning Objectives:

- To develop foundational skills in geological map interpretation and structural data analysis through hands-on laboratory exercises.
- To enable students to conduct field-based geological mapping and reconstruct the geological history of an area using three-dimensional spatial reasoning.
- To familiarize students with the identification of sedimentary rocks and the application of field techniques in geological oceanography.
- Identify and locate geological exposures in the field using topographic maps and field navigation techniques
- Accurately measure and record bed attitudes (strike and dip) and other structural features such as folds and faults
- Construct lithological columns and stratigraphic logs to represent vertical rock successions

- Correlate stratigraphic sections across different outcrops and interpret facies changes
- Interpret sedimentary structures and depositional environments based on field observations
- Prepare geological maps that incorporate lithological boundaries, structural elements, and stratigraphic units
- Document field data systematically using field notebooks, sketches, photographs, and standardized note-taking techniques
- Write a comprehensive field report, including maps, sections, interpretations, and summaries of field data

9) Course Learning Outcomes (CLO):

- **CLO1:** learn how to identify, describe, and document rock types, structures, and stratigraphic relationships in natural outcrops.
- **CLO2:** acquire practical skills in using topographic maps, compass-clinometers, GPS, and field notebooks to create accurate geological maps and cross-sections.
- **CLO3:** Recognize and record major structures, primary and secondary sedimentary structures, rock types, to construct litho-columns for construction of litho-stratigraphic succession
- **CLO4:** Construct litho-logs for interpreting and describing depositional environment of study area and compared with the stratigraphic column of Bangladesh
- **CLO5:** Be adept in grain size analysis, prepare cross-sections from Geological maps and reconstruct the geological history of the area
- **CLO6:** Infer the facies change scenario, prepare cross-sections, learn geological database management
- **CLO7:** gain the ability to reconstruct the geological evolution of an area based on field relationships, structural features, and stratigraphy.
- **CLO8:** apply critical thinking and field data analysis to interpret tectonic settings, resource potential, and geohazards.

10) **Mapping of CLOs with Program Learning Outcomes (PLOs):**

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	**3**	2	**3**	1	**3**	**3**	**3**	**3**	1
CLO 2	**3**	**3**	2	**3**	**3**	**3**	2	1	**3**	1
CLO 3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	2
CLO 4	**3**	**3**	**3**	**3**	1	**3**	**3**	**3**	**3**	**3**
CLO 5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CLO 6	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CLO 7	**3**	**3**	**3**	2	**3**	**3**	**3**	**3**	**3**	1
CLO 8	1	**3**	**3**	1	1	**3**	**3**	1	**3**	1

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

11) **Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques**

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	**Preparation for fieldwork:** 1. Introduction to geological fieldwork 2. Field equipment and safety 3. Field observation at different scales 4. Field notebook: sketches, written notes, correlation with other data, etc. 5. Recording features of sedimentary logs and constructing graphic logs 6. Recording palaeontological data 7. Recording structural information 8. Making a geological	1-5 hr	Lectures, Hands-On	Field Performance	CLO 1 CLO 2 CLO 3 CLO 4 CLO 5 CLO 6 CLO 7 CLO 8

	map 9. Photography, sampling, etc. 10. Laboratory analysis of samples and interpretation 11. Field report writing				
2	Fundamentals of analytical techniques used in field, field equipments, sampling strategy and field safety measures		Lectures		CLO 1 CLO 2 CLO 3
3	Geological fieldwork will involve observing, measuring, and sampling rocks, structures, and landforms to interpret an area's geological history. Tasks will encompass identifying lithologies, mapping structures, collecting samples, and recording precise locations with GPS. The collected data are later compiled to create a geological map showing surface geology and structural features	6-25 (6hrs/day X 5days; 30 hours equivalent to 20 lectures)		field training	CLO 1 CLO 2 CLO 3 CLO 4 CLO 5 CLO 6 CLO 7 CLO 8
4	Conduct a five-day geological fieldwork program in a well-exposed outcrop section to study the general geology of the area. The program focuses on developing essential field skills, including geological observation, documentation, and mesoscopic-scale mapping. Activities include observing exposed rock facies, mapping exercises, maintaining standardized field notes, constructing lithological columns, collecting rock samples, correlating lithological sections from different locations, interpreting the depositional environment and summarizing and plotting field data on a map at the end of each field day.		Lectures, Hands-On	Field Performance, Laboratory evaluation, Report submission	CLO 1 CLO 2 CLO 3 CLO 4 CLO 5 CLO 6 CLO 7 CLO 8
5	Assessment of Field Performance and Field Viva	26-29			CLO 1 CLO 2

		(6hrs/day; equivalent to 4 lectures)			CLO 3 CLO 4 CLO 5 CLO 6 CLO 7 CLO 8
6	Overall, Field Summary and Instructions on Field Report preparation	30			CLO 1 CLO 2 CLO 3 CLO 4 CLO 5 CLO 6 CLO 7 CLO 8

PART C

12) **Assessment and Evaluation**

Bloom's Category	**Semester Final Examination**			
	Attendance (10)	**Field Performance (30)**	**Report (40)**	**Presentation / Viva (20)**
Remember		5	5	5
Understand		5	5	5
Apply		5	5	5
Analyze		5	5	5
Evaluate		5	5	
Create		5	5	

PART D

13) Recommended References:

Text Book:

1. Coe, A.L. (2010) Geological Field Techniques. John Wiley & Sons.

Reference Book:

1. Lisle, R.J., Brabham, P.J., Barnes, J.W. (2011) Basic Geological Mapping (5th Edition). Wiley- Blackwell.
2. Coe, A.L. (2010) Geological Field Techniques. John Wiley & Sons.
3. Collinson, J., Mounney, J.N. and Thompson, D. (2006) Sedimentary Structures. 3rd Edition. Terra Publishing, England, 292 p. https://www.amazon.com/Sedimentary-Structures-Third-John- Collinson/dp/190354419X
4. Barnes, J.W. & Lisle, R.J. (2004) Basic Geological Mapping (4th Edition). John Wiley & Sons.
5. McClay, K.R. (1987) The Mapping of Geological Structures (Reprinted 2007). John Wiley & Sons.
6. Compton, R.R. (1962) Manual of Field Geology. Wiley.
7. Lahee, F.H. (1961) Field Geology (6th Edition). McGraw-Hill Book Co.

8. Low, J.W. (1957) Geological Field Methods. Harper & Bros.
9. Pettijohn, F.J. (2004) Sedimentary Rocks (3rd edition). CBS Publisher.
10. Tucker, M. E. (Ed.) (2013) Sedimentary petrology: an introduction to the origin of sedimentary rocks (3rd Edition). John Wiley & Sons.
11. Boggs, S. Jr. (2014) Principles of sedimentology and stratigraphy (5th Edition). Pearson.
12. Reimann, K. U. (1993) Geology of Bangladesh. Gebruder Borntraeger Verlagsbuchhandlung, Science Publishers.
13. Khan, F. H. (1991). Geology of Bangladesh. Wiley Eastern.

Detail Syllabus Fifth Semester
(Year-3, Semester-1)

Course Title: Ocean Optics	
Course Code: OCN 3101	**Credit: 2.0**

PART A

1) **Course Code:** OCN 3101
2) **Course Title:** Ocean Optics
3) **Course Type:** CC
4) **Year and Semester:** Year 3, Semester 1
5) **Prerequisite: N/A**
6) **Credit**: 2
7) **Contact Hours:** 28
8) **Total Marks:** 100
9) **Course Summary and Objectives**

This course provides an introduction to the optical properties of seawater and the principles governing the interaction between light and ocean constituents. It covers key concepts such as inherent and apparent optical properties, radiative transfer theory, light attenuation, optical instrumentation, and basic ocean color remote sensing.

Course Objectives

- To explain the nature and behavior of light in the marine environment.
- To understand how light interacts with different water constituents.
- To introduce instrumentation and methods for measuring ocean optical properties.
- To build a conceptual foundation for ocean color remote sensing.

10) **Course Learning Outcomes (CLOs)**

i. CLO1: Describe the fundamental behavior of light in seawater and define key optical terms.
ii. CLO2: Explain the interaction of light with various water constituents including CDOM and particles.
iii. CLO3: Identify and explain the function of ocean optics instruments and calibration practices.
iv. CLO4: Interpret ocean color remote sensing principles and basic applications.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	**3**	1	1	1	1	1	2	**3**	1
CLO 2	**3**	**3**	**3**	1	**3**	1	1	2	**3**	1
CLO 3	**3**	**3**	**3**	**3**	2	1	1	2	**3**	**3**
CLO 4	**3**	**3**	**3**	**3**	2	1	1	2	**3**	**3**

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Nature of light, solar radiation at ocean surface, radiometric quantities	Week 1	Lecture, diagram explanation, whiteboard derivation	Quiz, class interaction	CLO1
2	Inherent and apparent optical properties (IOPs, AOPs)	Week 2	Concept breakdown, case visuals	Assignment	CLO1
3	Light attenuation: Beer's Law, Gershun's Law, diffuse attenuation coefficient	Week 3	Equation analysis, real-world examples	Problem set	CLO1
4	Radiative transfer and light-matter interaction; absorption, scattering	Week 4	Conceptual modeling, discussion	Quiz	CLO2
5	CDOM and particle optics; phytoplankton and pigments	Week 5	Examples, case studies, animation videos	Short answer task	CLO2
6	Ocean optics instrumentation: radiometers,	Week 6	Instrumental demo (images/videos), guest note	Assignment	CLO3

	spectroradiometers, calibration				
7	Mid-Term Examination Remote Sensing Reflectance (Rrs)	Week 7	— Instrumental demo (images/videos)	Mid-Term Exam (15%) Short answer task	CLO3
8	Chlorophyll fluorescence and bio-optical sensors	Week 8	Application video demo, dataset review	Quiz	CLO3
9	Ocean color remote sensing basics	Week 9	Lecture, timeline of missions	MCQ + response sheet	CLO4
10	Atmospheric correction and Rrs inversion principles	Week 10	Band ratio demo, guided walkthrough	Assignment	CLO4
11	Remote sensing applications: phytoplankton, CDOM, turbidity	Week 11	Case exploration, research example walk-through	Class test	CLO4
12	Digital platforms: NASA OceanColor, Copernicus Marine	Week 12	Live data demo, student activity	Data-based assignment	CLO4
13	AI/ML applications in satellite ocean color data interpretation	Week 13	Live data demo, student activity	Interactive discussion	CLO1–CLO4
14	Final assignment presentation or interpretation task	Week 14	Mini presentation or write-up	Final Assignment/Presentation (15%)	CLO4

PART C

15) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	2		2	10
Understand		1	2	1	3	10
Apply	**5**	1	2	1	2	15

Analyze		1	2	1	3	15
Evaluate		1		1	2	5
Create			2	1	3	5

PART D

Suggested Readings

- Mobley, C.D. (1994). *Light and Water: Radiative Transfer in Natural Waters*. Academic Press.
- Kirk, J.T.O. (2011). *Light and Photosynthesis in Aquatic Ecosystems*. Cambridge University Press.
- IOCCG Reports (https://ioccg.org/)
- Stewart, R. H. *Introduction to Physical Oceanography* – chapters relevant to optics.
- IOCCG. (2022). *Ocean Colour Remote Sensing for Beginners* (free PDF).

Course Title: Computer Methods in Earth and Ocean Sciences	
Course Code: OCN 3103	**Credit: 3.0**

1) Course Code: OCN 3103

2) Course Title: Computer Methods in Earth and Ocean Sciences

3) Course Type: CC

4) Year and Semester: Year 3, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course introduces students to fundamental computational methods and programming techniques essential for solving problems in Earth and Ocean Sciences. Topics include numerical methods, data processing, visualization, and an introduction to modeling. Students will gain hands-on experience with relevant software tools and programming languages to analyze and interpret scientific data. The course aims to develop the computational skills required for real-world Earth and Ocean Science problems.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Apply computational thinking to Earth and Ocean Science problems, including numerical and data processing techniques.
ii. **CLO 2:** Utilize programming languages (e.g., Python, MATLAB) for scientific computing and solving Earth and Ocean Science problems.
iii. **CLO 3:** Implement numerical methods for data analysis, simulation, and interpretation of scientific datasets.
iv. **CLO 4:** Process, analyze, and visualize large scientific datasets, focusing on applications in oceanography, meteorology, and geology.
v. **CLO 5:** Develop basic computational models for Earth and Ocean processes and validate them through testing and analysis.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	**3**	**3**	**3**	**3**	**3**	2	1	**3**	1
CLO 2	**3**	**3**	**3**	2	2	2	**3**	1	**3**	1
CLO 3	1	**3**	2	**3**	2	2	**3**	1	**3**	1
CLO 4	**3**	2	**3**	**3**	2	2	**3**	1	**3**	1
CLO 5	**3**	**3**	**3**	2	**3**	2	2	1	**3**	**3**

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	**Introduction to Scientific Computing in Earth & Ocean Sciences:** Role of computation in modern Earth and Ocean Sciences research. Overview of programming languages (Python, MATLAB/Octave) and their applications. Introduction to integrated development environments (IDEs) and scientific libraries.	Week-1	Lecture, Group Discussion	Assignment on the importance of computational methods in Earth Sciences	CLO 1
2	**Programming Fundamentals for Scientific Applications:** Review of core programming concepts: variables, data types, control flow, functions. Working with arrays and matrices (NumPy), File I/O for scientific data (NetCDF, HDF5, CSV).	Week-2	Lecture, Hands-on Coding	Quiz on basic programming and I/O operations	CLO 2
3	**Numerical Methods for Earth & Ocean Sciences:** Solving linear equations	Week-3-4	Lecture, Practical Exercises	Lab report on solving numerical	CLO 2, CLO 3

	(Gaussian elimination, iterative methods), Interpolation and extrapolation, Numerical differentiation and integration, Root finding algorithms, Introduction to ODEs and their numerical solutions.			problems using Python/Matlab	
4	**Data Processing and Analysis:** Handling large datasets, filtering, smoothing, and resampling. Statistical analysis of scientific data, Time series analysis: spectral analysis, filtering. Geospatial data processing and analysis.	Week-5-6	Hands-on Coding, Data Analysis	Lab work on data processing and time series analysis	CLO 3
5	**Mid-Term Examination** **Time series analysis:** spectral analysis, filtering. Geospatial data processing and analysis.	Week-7	- Hands-on Coding, Data Analysis	- Lab work on data processing and time series analysis	CLO 3
5	**Introduction to Computational Modelling:** Concepts of physical and numerical models. Building simple models for Earth and Ocean processes (e.g., heat transfer, diffusion). Introduction to finite difference methods. Model validation and sensitivity analysis.	Week-9-10	Lecture, Group Discussion	Assignment on building basic computational models	CLO 5
6	**Case Studies and Applications:** Applying computational methods to real-world problems in oceanography, meteorology, and geology. Examples include ocean circulation modeling, climate data analysis, and seismic wave propagation.	Week-11-12	Case Study Analysis, Discussion	Presentation of case study results	CLO 1, CLO 5

PART C

13) Assessment and Evaluation

Bloom's Category	Continuous Internal Evaluation					Semester Final Examination
	Attend. (05)	Class Performance (05)	Class Tests (10)	Assign. (05)	Mid Term (15)	Final (60)
Remember		1	2		2	10
Understand		1	2	1	3	10
Apply	5	1	2	1	2	15
Analyze		1	2	1	3	15
Evaluate		1		1	2	5
Create			2	1	3	5

PART D

Reference Books:

1. Johansson, R. (2019). *Numerical Python: A Practical Techniques Approach for Industry*. Apress.
2. Versteeg, H. K., & Malalasekera, W. (2007). *An Introduction to Computational Fluid Dynamics: The Finite Volume Method*. Pearson Education.

Course Title: Computer Methods in Earth and Ocean Sciences Lab	
Course Code: OCN 3104	**Credit: 1.5**

PART A

1) Course Code: OCN 3104

2) Course Title: Computer Methods in Earth and Ocean Sciences Lab

3) Course Type: SKD

4) Year and Semester: Year 3, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 1.5

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This laboratory course complements the theoretical concepts introduced in Computer Methods in Earth & Ocean Sciences by providing hands-on experience with computational tools and programming for Earth and Ocean Science applications. Students will work through practical exercises and small projects, focusing on data acquisition, processing, analysis, and visualization using relevant software and programming languages. The course aims to develop practical computational skills and ensure students can apply theoretical concepts to real-world problems in Earth and Ocean Sciences.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Apply programming skills to solve practical problems in Earth and Ocean Sciences using Python and MATLAB.
ii. **CLO 2:** Effectively use scientific computing libraries (e.g., NumPy, Pandas, Matplotlib, SciPy) for data manipulation and analysis.
iii. **CLO 3:** Create professional-quality visualizations of scientific data, including geospatial and time-series data.
iv. **CLO 4**: Debug and troubleshoot computational scripts to ensure reliable and accurate results.
v. **CLO 5**: Document and present computational work clearly, with attention to scientific communication standards.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	3	3	3	3	2	3	2	1	3	1
CLO 2	3	3	3	2	1	2	2	1	3	1
CLO 3	2	3	2	3	1	2	3	1	2	1
CLO 4	1	2	3	3	1	3	3	1	3	1
CLO 5	3	3	3	2	3	2	2	1	3	3

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	**Introduction to the Lab Environment:** Setting up the computational environment (Python, Jupyter Notebooks, relevant libraries). Review of basic Python syntax and data structures for lab work.	Week-1-2	Lecture, Hands-on Setup	Assignment on setting up the environment and initial code exercises	CLO 1
2	**Data Acquisition and Handling Lab:** Downloading and loading real-world Earth and Ocean Science datasets. Working with different data formats (CSV, NetCDF, HDF5). Basic data cleaning and preprocessing exercises.	Week-3-4	Hands-on Lab, Data Cleaning	Lab report on data loading and preprocessing	CLO 2
3	**Numerical Methods in Practice Lab:** Implementing numerical integration and differentiation for oceanographic profiles. Solving simple linear systems related to geophysical measurements. Curve fitting and interpolation exercises.	Week-5-6	Practical Exercises	Report on numerical methods and solutions	CLO 2, CLO 3
4	**Data Analysis and Statistics Lab:** Applying descriptive statistics to environmental datasets. Performing basic hypothesis tests on oceanographic data. Time series analysis exercises (e.g., calculating	Week-7-8	Hands-on Data Analysis	Lab work on applying statistical methods to datasets	CLO 3

	moving averages, basic spectral analysis).				
5	**Scientific Visualization Lab:** Creating various types of plots (scatter, line, contour, 3D) using Matplotlib and Seaborn. Visualizing ocean currents, temperature, and salinity fields. Generating animations of time-varying data.	Week-9-10	Hands-on Coding, Data Visualization	Lab report on visualization techniques	CLO 3, CLO 4
6	**Introduction to Modelling Lab:** Building and running simple 1D or 2D numerical models (e.g., diffusion in a water column). Visualizing model outputs and comparing with observed data. Sensitivity analysis of model parameters.	Week-11-12	Hands-on Modelling	Assignment on model construction and results presentation	CLO 5
7	**Project-Based Learning:** Small group projects applying learned computational methods to a specific Earth or Ocean Science problem. Presentation of project results.	Week-13-14	Group Project, Presentation	Group project presentation	CLO 1, CLO 5

PART C

13) Assessment and Evaluation

Bloom's Category	**Semester Final Examination**				
	Attend. (10)	**Class Performance (10)**	**Assign. / Report (20)**	**Present. / Viva (20)**	**Final (40)**
Remember		2		4	5
Understand		2	4	6	5
Apply	5	2	4	2	10
Analyze		2	4	3	10
Evaluate		2	4	2	5
Create			4	3	5

PART D

14) Reference Books:

4. Johansson, R. (2019). *Numerical Python: A Practical Techniques Approach for Industry*. Apress.
5. Versteeg, H. K., & Malalasekera, W. (2007). *An Introduction to Computational Fluid Dynamics: The Finite Volume Method*. Pearson Education.

Course Title: Ocean Governance	
Course Code: OCN 3105	**Credit: 3.0**

PART A

1) Course Code: OCN 3105

2) Course Title: Ocean Governance

3) Course Type: Core Course

4) Year and Semester: Year 3, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives

This course provides an in-depth exploration of ocean governance mechanisms with a strong emphasis on the United Nations Convention on the Law of the Sea (UNCLOS). It covers legal, political, and scientific dimensions of ocean management including marine pollution, conservation, fisheries regulation, maritime transport, climate change, stakeholder engagement, and the role of science in policy. Case studies and international frameworks are examined with particular focus on the application of UNCLOS provisions. Course objectives include –

- To develop a solid understanding of UNCLOS and its pivotal role in international ocean governance.
- To examine the legal and institutional mechanisms addressing marine environmental issues and sustainable resource use.
- To assess how science, international cooperation, and stakeholder participation shape effective ocean policy.
- To critically evaluate governance responses to emerging challenges like deep-sea mining and climate impacts.

10) Course Learning Outcomes (CLO):

a) **CLO 1:** Understand the ocean, and ocean governance in the context of Bangladesh, and principles of ocean governance.
b) **CLO 2:** Analyze international conventions, treaties, and maritime laws.
c) **CLO 3:** Explore the role of national and regional institutions in managing marine resources.
d) **CLO 4:** Evaluate environmental, economic, and social dimensions of ocean governance.
e) **CLO 5:** Apply governance concepts to issues like climate change, fisheries, marine biodiversity, marine scientific research and pollution.

10) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	2	3	3	2	2	2	3	2	1	2
CLO 2	2	3	2	2	3	2	2	3	1	3
CLO 3	2	3	3	2	2	3	2	3	2	2
CLO 4	3	3	3	2	3	3	2	2	3	2
CLO 5	2	2	3	3	3	3	3	2	2	3

(Weightage: 3-High, 2-Medium, 1-Low)

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	▪ **Introduction to Ocean Governance: Principles, Challenges, and Sustainability** ▪ **UNCLOS framework:** – Definition, scope, and importance of ocean governance ▪ **Historical evolution of ocean governance: past, present, and future** ▪ **Ocean governance in the context of the Bay of Bengal**	Week 1–2	Lecture, PPT, maps, legal interpretations, and exercises	Quiz / Short descriptive questions	CLO 1, CLO 2
2	▪ **Global Institutions and Agreements** – Roles of UN, IMO, FAO, UNEP – International treaties on shipping, pollution, and marine safety ▪ **Regional Cooperation and Governance**	Week 3	Lecture, PPT, legal interpretations	Quiz / Short descriptive questions	CLO 1, CLO 2, CLO 3

	– Regional initiatives: BIMSTEC, IORA, SAARC coastal programs – Role of regional sea programmes				
3	**National Ocean Policies and Governance** – Institutional structures and frameworks in Bangladesh – Marine Spatial Planning (MSP) and governance practices in Bangladesh – Comparative analysis with other coastal states	Week 4	Lecture, PPT, debates, legal interpretations, exercises	Quiz / Short descriptive questions	CLO 2, CLO 3, CLO 4
4	**Maritime Disputes and Legal Bodies** – ITLOS – ICJ – Judicial mechanisms for dispute resolution under UNCLOS – Permanent Court of Arbitration – Admiralty courts in Bangladesh	Week 5	Lecture, charts, PPT, legal interpretations, group exercises	Quiz / Short descriptive questions	CLO 1, CLO 2, CLO 5
5	**Fisheries and Ocean Governance** – Sustainable fisheries management – Regional Fisheries Management Organizations (RFMOs) – Illegal, Unreported, and Unregulated (IUU) fishing	Week 6	Lecture, PPT, group exercises, marine species profiling	Quiz / Short descriptive questions	CLO 1, CLO 2, CLO 3, CLO 5
6	▪ ***Mid-Term Examination (15 Marks)*** ▪ **Marine Environmental Protection** – Marine pollution: oil spills, plastics, land-based sources – International conventions: MARPOL, London Convention	Week 7	Lecture, PPT, maps, legal interpretations, shipping case discussions	Mid-Term Exam / Short descriptive questions	CLO 1, CLO 2, CLO 4, CLO 5
7	**Marine Biodiversity and Conservation** – High seas biodiversity – Marine Protected Areas (MPAs)	Week 8	Lecture, PPT, charts, legal aspects, discussions	Quiz / Short descriptive questions	CLO 1, CLO 2

	– Convention on Biological Diversity (CBD)				
8	**Ocean and Climate Change** – Sea level rise and ocean acidification– Climate adaptation and mitigation strategies– Roles of IPCC and COP in ocean-related issues	Week 9	Lecture, PPT, maps, legal interpretations, exercises	Quiz / Short descriptive questions	CLO 1, CLO 2, CLO 5
9	**Blue Economy and Ocean Governance** – Concept and principles of the Blue Economy – Major ocean industries: shipping, tourism, energy, biotechnology	Week 10	Lecture, PPT, maps, extraction plans, economic analysis	Quiz / Short descriptive questions	CLO 1, CLO 2, CLO 5
10	**Security and Ocean Governance** – Maritime security, piracy, and trafficking – Safety and autonomous vessels – Roles of navies and coast guards	Week 11	Lecture, PPT, global/regional cooperation discussions, economic analysis	Quiz / Short descriptive questions	CLO 1, CLO 2, CLO 3
11	**Emerging Issues in Ocean Governance** – Deep-sea mining and marine genetic resources – Digitalization and ocean data governance	Week 12	Lecture, PPT, legal analysis, stakeholder perspectives, security implications	Quiz / Short descriptive questions	CLO 1, CLO 2, CLO 3
12	**Case Studies and Course Review** – Case studies on Bangladesh's ocean governance challenges – Student presentations and review sessions – Comparative analysis: • Bay of Bengal: Bangladesh–India and Bangladesh–Myanmar maritime delimitation disputes • South China Sea: China–Philippines sovereignty and EEZ conflict over islands and reefs • Spratly Islands: Overlapping claims by China, Vietnam, Malaysia,	Week 13–14	Case studies, group tasks, PPT, discussions	Case Study/ Assignment/ presentation	CLO 1, CLO 2

	Philippines and Brunei • Algeria: Algeria–Spain and Algeria–France EEZ declaration controversy in the Western Mediterranean • Denmark: Denmark–Canada boundary dispute over Hans Island in the Nares Strait • North Sea (UK): Denmark–Netherlands–Germany continental-shelf delimitation cases and subsequent UK–Norway North Sea boundary agreements				

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5		3	10
Understand		1	5		3	10
Apply	5				2	10
Analyze		1		2	3	15
Evaluate		1		2	2	10
Create		1		1	2	5

PART D

16) Textbook:

- Jones, Catherine (Ed.). *Governing Oceans*. Routledge.

17) Reference Books:

1. Hornidge, Anna-Katharina (Ed.). *Ocean Governance*.
2. United Nations Convention on the Law of the Sea (UNCLOS)
3. International Maritime Organization (IMO) Publications
4. FAO. *Code of Conduct for Responsible Fisheries*

5. UNEP. *Marine Litter and Pollution Reports*
6. IPCC Reports on Ocean and Cryosphere (2019)
7. WWF and IUCN Ocean Policy Briefs

Course Title: Coastal Oceanography and Morphology	
Course Code: OCN 3107	**Credit: 3**

PART A

1) Course Code: OCN 3107

2) Course Title: Coastal Oceanography and Morphology

3) Course Type: CC

4) Year and Semester: Year 3, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course would provide knowledge of oceanographic processes and morphology of the coastal zone and quantitative investigations into the origin/evolution of coastal landforms and the physical processes responsible for their creation and modification of configuration. It introduces students to the study of coastal oceanic process with a focus on physical, chemical and geomorphological processes in the nearshore that transport sediments and create changes in coastal morphology. The objectives are as follows -

- To learn about the classification and characteristics of coasts.
- To get knowledge about the origin, formation, and evolution of coasts.
- To understand physical, chemical, geomorphology processes along with human stressors.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Learn the basic oceanic process and geomorphology of the coasts and various coastal processes.

ii. **CLO 2:** Understand the origin, formation and evolution of coasts.

iii. **CLO 3:** Know different types of coasts and the characteristics.

iv. **CLO 4:** Identify the primary processes that shape the coastal zone and drive changes in coastal morphology

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / **CLO**	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	1	1	1	**3**	**3**	**3**	2	2	1
CLO 2	1	1	**3**	1	2	**3**	2	2	2	1
CLO 3	1	**3**	2	**3**	2	**3**	2	2	**3**	2
CLO 4	1	**3**	2	2	2	**3**	2	**3**	2	1

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	**Introduction to Coastal Oceanography:** Definition and scope of coastal oceanography, Importance of the coastal zone, Classification of coast: process-based classification, tectonic classification, Coastal vs open ocean systems.	Week-1	Lecture, Discussion	CT-01	CLO 1
2	**Coastal Geomorphology and Sediment Dynamics:** Coastal landforms and sediment types, Erosion, accretion, beach configuration and sediment transport, Estuarine and deltaic processes, Barrier islands, lagoons, and tidal inlets, Sediment dynamics quantification, Bedload vs suspended load, Rouse profile, Depositional environment.	Week-2 Week-3	Lecture, Discussion, Video Presentation	Class performance and interactions	CLO 1, CLO 3
3	**Waves, Tides, and Currents in Coastal Areas:** Types and generation of ocean waves, wave breaking, storm-induced wave, Tidal dynamics and tidal range, Wind-driven and density-driven currents, Nearshore wave transformation and longshore drift.	Week-4 Week-5	Interactive discussion	CT-02	CLO 1 CLO 2
4	**Coastal Circulation and Mixing Processes:** Estuarine circulation patterns, Upwelling and downwelling in coastal zones, Stratification and mixing, Influence of river discharge and freshwater fluxes.	Week-6 Week-7	Power point presentation, white board illustration	Sketching the diagrams	CLO 2, CLO 4
5	**Mid-Term**	Week-8	-	-	-

	Stratification and mixing, Influence of river discharge and freshwater fluxes.		Power point presentation, white board illustration	Sketching the diagrams	CLO 2, CLO 4
6	**Coastal Water Quality and Biogeochemical Processes:** Nutrient cycling in coastal waters, Eutrophication and hypoxia, Organic carbon and sediment interactions, Pollutant transport and residence time	Week-9	Lecture, Discussion	Class performance and interactions	CLO 2
7	**Ecosystems of the Coastal Ocean:** Coral reefs, mangroves, and salt marshes, Estuarine and lagoonal ecosystems, Biodiversity and ecosystem services, Human impacts on coastal ecosystems.	Week-10	Lecture, independent reading	Assignment	CLO 1, CLO 3
8	**Coastal Hazards and Climate Change Impacts:** Sea level rise and storm surges, Coastal flooding, erosion, and subsidence, Climate change effects on coastal dynamics, Vulnerability and risk assessment	Week-11	Power point presentation, white board illustration	CT-03	CLO 1 CLO 3
9	**Human Activities and Coastal Management:** Coastal development and land use changes, Port, tourism, and aquaculture impacts, Marine spatial planning, Integrated coastal zone management (ICZM), Human induced stressors: habitat loss, invasive species, pollution	Week-12	Power point presentation, white board illustration	Brain-storming and performance	CLO 1, CLO 3
10	**A case study: Bangladeshi Coast:** Geomorphology and evolution of the Bangladesh coasts	Week-13	Power point presentation, white board illustration	CT-04	CLO 3
11	**Recap & Problem-Solving**	Week-14	Power point presentation		

PART C

13) Assessment and Evaluation

Bloom's Category	Continuous Internal Evaluation					Semester Final Examination
	Attend. (05)	Class Performance (05)	Class Tests (10)	Assign. (05)	Mid Term (15)	Final (60)
Remember		1	5		3	10
Understand		1	5		3	10
Apply	5				2	10
Analyze		1		2	3	15
Evaluate		1		2	2	10
Create		1		1	2	5

PART D

14) Reference Books

- Coastal Hydraulics, by A.M. Muir Wood, Palgrave (2nd edition, 2014), ISBN: 134904508X.
- The Earth and its Ocean, by A.C. Duxbury, Addison-Wesley Pub. Co. (1971).
- Introduction to Coastal Processes and Geomorphology, by Robin Davidson-Arnott, Cambridge University Press, ISBN: 0521696712.
- Coastal Geomorphology: An Introduction, by Eric Bird, John Wiley and Sons ltd, ISBN:
- 0470517301.
- Introduction to Coastal Processes & Geomorphology, 2nd Edn., 2011, by Gerhard Masselink, Michael G. Hughes, and Jasper Knight; ISBN: 978-1444122404; Publisher: Hodder Education
- Beach Processes and Sedimentation (2nd Ed.) by Paul Komar, 1998, Prentice-Hall
- Coastal Processes with Engineering Applications, by Robert G. Dean and Robert A. Dalrymple, 2002, Cambridge University Press

Course Title: Geophysics	
Course Code: OCN 3109	Credit: 3.0

PART A

1) Course Code: OCN 3109

2) Course Title: Geophysics

3) Course Type: FC

4) Year and Semester: Year 3, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course provides a comprehensive introduction to the fundamental principles and techniques of geophysics, emphasizing the use of physical laws to explore and understand the Earth's interior and surface processes. Key topics include gravitational and magnetic fields, seismic wave propagation, Earth's thermal structure, and electrical and electromagnetic methods. Students will learn how geophysical data are collected, analyzed, and interpreted to investigate subsurface structures and processes. Emphasis is placed on the practical applications of geophysics in resource exploration, environmental studies, and tectonic research, equipping students with a strong foundation for advanced study.
The objectives of this course are:

- Understand the Earth's internal structure and the physical principles governing geophysical processes
- Learn the basic concepts of gravity, magnetism, heat flow, and seismic wave propagation used in subsurface investigations
- Gain knowledge of the techniques and instruments used in geophysical surveys and data acquisition
- Develop the ability to interpret geophysical anomalies and relate them to geological structures and processes
- Explore the practical applications of geophysics in natural resource exploration, earthquake studies, and environmental assessment

10) Course Learning Outcomes (CLOs):

i. CLO1: gain foundation knowledge of Earth’s internal structure, common geophysical methods and their applications and earth’s geophysical entities

ii. CLO2: understand the working principles, driving forces, application and anomalies associated with different geophysical properties of the Earth

iii. CLO3: attain knowledge of instrumentation for recording geophysical anomalies in a heterogeneous environment, analyze the data for geophysical interpretation for explaining various geological phenomena

iv. CLO4: Apply the geophysical methods to solve different environmental and geological problems

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	1	**3**	1	1	**3**	**3**	2	**3**	1
CLO 2	**3**	**3**	**3**	2	**3**	**3**	**3**	2	**3**	1
CLO 3	2	**3**	2	**3**	2	**3**	**3**	**3**	**3**	**3**
CLO 4	1	**3**	2	**3**	**3**	2	**3**	2	**3**	**3**

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Topic	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Introduction to Geophysics: Scope, history,and branches of geophysics; relevance in Earth sciences Earth's interior: layers, composition, physical properties, methods of study Geophysical Fields: Overview of gravity, magnetic, electrical, and electromagnetic fields Wave Motion: Seismic wave velocity, reflection, refraction, attenuation	Week-1	Lecture, Discussion	Assignment	CLO 1
2	Geoid, reference ellipsoid, variations in Earth's gravity field	Week-2	Lecture, Discussion,	Class performance	CLO 1

	Principles of Gravity Measurement: Gravimeters, corrections (latitude, elevation, drift, tide) Basics of Gravity Anomalies: Concept of gravity anomalies and qualitative insights			and interactions	
3	Fundamental understanding of how density differences affect gravity (no advanced interpretation)	Week-3	Lecture	Class Test/Quiz-1	CLO 1
4	Origin of geomagnetic field, dipole approximation, secular variation Paleomagnetism: Magnetic minerals, remanent magnetization, rock magnetic behavior Magnetic Field Measurement: Magnetometers and field surveys, introduction to magnetic maps Magnetic Field Variations: Diurnal, seasonal, and storm-related variations in magnetic field	Week-4	Interactive discussion, white board illustration	Presentation, interactions	CLO 1, CLO 4
5	Earthquakes and Tectonics: Stress and strain, faulting, earthquake genesis Seismic Waves	Week-5	Power point presentation, white board illustration	Assignment	CLO 1, CLO 2, CLO 4
6	Seismic Data Basics: Travel-time curves, seismic ray paths, shadow zones	Week-6	Power point presentation, white board illustration, discussion on assignments	Oral viva, interactions	CLO 2, CLO 4
7	Mid Term Examination **Earth's Internal Structure:** Seismology-based layers (Moho,	Week-7	- Power point presentation, white board	- Oral viva, interactions	 CLO 2, CLO 4

	outer/inner core), basic models		illustration, discussion on assignments		
8	Introduction to Basic Electrical Surveys: Resistivity, current flow in subsurface, Field procedures and fundamental interpretation of resistivity profiles	Week-8	Power point presentation, white board illustration, discussions on mid-term scripts	Sketching the diagrams	CLO 2, CLO 4
9	Introduction to Geophysical Data: Nature of geophysical data, noise vs signal, simple data processing Introduction to Geophysical Instrumentation: Basic overview of instruments for gravity, magnetic, seismic, electrical methods	Week-9	Lecture, Discussion	Class Test/Quiz-2	CLO 2, CLO 3
10	**Principles and Data Acquisition:** Gravity Methods: Introduction to Gravity Methods, Data Acquisition Techniques, Data Processing and Interpretation, Application and challenges in interpretation Magnetic Methods: Principles of magnetic surveys Data acquisition, interpretation, and applications Electrical Methods	Week-10	Lecture, independent reading	Group assignment	CLO 1, CLO 2, CLO 3

11	Electrical Methods: Principles of Electrical Methods Instruments, data acquisition and interpretation techniques	Week-11	Power point presentation, white board illustration, interactive Q&A	Brain-storming and performance	CLO 2, CLO 4
12	Seismic Methods: Principles of seismic methods, Acquisition, processing and interpretation, Applications and case studies	Week 12	Power point presentation, white board illustration	Class Test/Quiz-3	CLO 3, CLO 4
13	Geophysical map generation, seismic attribute analysis, stratigraphic interpretation, seismic facies analysis Hydrocarbon traps and reservoir analysis	Week-13	Power point presentation, white board illustration, independent reading	Assignment	CLO 3
14	Mineral exploration geophysics: Integration of Geophysical Data in Mineral Exploration	Week-14	Power point presentation, white board illustration	Group Presentation	CLO 3, CLO 4

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5		3	10
Understand		1	5		3	10
Apply	5				2	10
Analyze		1		2	3	15
Evaluate		1		2	2	10
Create		1		1	2	5

PART D

14) Textbook:

Lowrie, W. (2007). *Fundamentals of Geophysics* (2nd Edition). Cambridge University Press.

15) Reference Books

1. Sheriff, R. E. & Geldart, L. P. (1995). Exploration Seismology (2nd Edition). Cambridge University Press.
2. Telford, W. M., Geldart, L. P. & Sheriff, R. E. (1990). Applied Geophysics (2nd Edition). Cambridge University Press.
3. Kearey, P., Brooks, M. & Hill, I. (2002). An Introduction to Geophysical Exploration (3rd Edition). Wiley-Blackwell.
4. Hinze, W. J., Von Frese, R. R. B. & Saad, A. H. (2013). Gravity and Magnetic Exploration: Principles, Practices, and Applications. Cambridge University Press.
5. Mussett, A. E. & Khan, M. A. (2000). Looking into the Earth: An Introduction to Geological Geophysics. Cambridge University Press.
6. Reynolds, J. M. (2011). An Introduction to Applied and Environmental Geophysics (2nd Edition). Wiley-Blackwell.
7. Dobrin, M. B. & Savit, C. H. (1988). Introduction to Geophysical Prospecting (4th Edition). McGraw- Hill.
8. Sharma, P. V. (1985). Geophysical methods in geology.
9. Kearey, P., Brooks, M., & Hill, I. (2013). An introduction to geophysical exploration. John Wiley & Sons.
10. Dentith, M., & Mudge, S. T. (2014). Geophysics for the mineral exploration geoscientist. Cambridge University Press.

Course Title: Acoustical Oceanography	
Course Code: OCN 3111	**Credit: 2.0**

PART A

1) Course Code: OCN 3111

2) Course Title: Acoustical Oceanography

3) Course Type: CC

4) Year and Semester: Year 3, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 2

7) Contact Hours: 28

8) Total Marks: 100

9) Course Summary and Objectives

This course provides a comprehensive foundation in the principles and techniques of underwater acoustics and their application to oceanographic studies. It covers wave theory, ray and mode formulations, inverse methods, and real-world acoustic systems used in ocean exploration. Emphasis is placed on both theoretical derivations and computational solutions relevant to coastal and deep-ocean environments.

Course Objectives:

- To introduce the physical foundations and mathematical frameworks of underwater sound propagation.
- To understand ray theory, mode theory, and wavenumber integration in acoustic modeling.
- To examine acoustic scattering and remote sensing applications in oceanography.
- To explore modern instrumentation and inverse methods in acoustical oceanographic studies.

10) Course Learning Outcomes (CLOs)

i. **CLO 1**: Understand the basic physics of sound propagation in the ocean, including wave equations, reflection, and boundary conditions.

ii. **CLO 2**: Apply ray theory, normal mode theory, and wavenumber integration methods to analyze ocean acoustic propagation.

iii. **CLO 3**: Evaluate acoustic scattering and inverse methods used in oceanographic studies and seabed characterization.

iv. **CLO 4**: Analyze real-world applications of acoustical oceanography such as tomography, ADCPs, and acoustic imaging.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	3	3	2	1	1	1	1	2	3	1
CLO 2	2	3	3	1	1	1	1	2	3	1
CLO 3	2	3	3	3	1	1	1	2	3	2
CLO 4	3	3	3	3	2	1	1	3	3	3

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) **Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques**

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Fundamentals of Ocean Acoustics: wave equation, impedance, intensity, boundary conditions	Week 1	Lecture, conceptual discussion, visual aids	Quiz, interaction	CLO 1
2	Green functions, Rayleigh/Fresnel reflection, method of images, Lloyd mirror	Week 2	Whiteboard explanation, derivations	Homework assignment	CLO 1
3	Ray theory: eikonal & transport equations, coherent/incoherent loss, Fermat's principle	Week 3	Visual derivations, ray-tracing demos	Class test	CLO 2
4	Gaussian beams, WKB ray theory, transition to modes	Week 4	Group problem solving, ray-to-mode illustration	Quiz	CLO 2
5	Normal mode theory: separation of variables, waveguide solutions, phase/group velocity	Week 5	Mode simulation, software-based examples	Assignment	CLO 2
6	Wavenumber integration	Week 6	Numerical method demos, code snippets	Problem-based exercise	CLO 2
7	Mid-Term Examination	Week 7	–	Mid-Term (15 marks)	– CLO 2

	Hankel transform, adiabatic approximation		Numerical method demos, code snippets		
8	Ray–mode connection, horizontal Lloyd mirror, perturbation theory	Week 8	Case-based analysis, visual demos	Short questions	CLO 3
9	Finite difference, shooting method, root finding, stepwise coupling	Week 9	MATLAB/Python demo, guided coding	Quiz	CLO 3
10	Rough surface scattering, Helmholtz integral, MSP, modal scattering	Week 10	Lecture + visualizations of scattering models	Assignment	CLO 3
11	Applications: tomography, ADCP, RAFOS/SOFAR, acoustic imaging	Week 11	Real case walkthrough, instrument demo	Short project report	CLO 4
12	Inverse methods: Tikhonov, Bayesian, nonlinear, seabed inversion	Week 12	Group simulation with example datasets	Class presentation	CLO 4
13	Recap of propagation methods and acoustic data applications	Week 13	Student-led review session	Participation	CLO 4
14	Final assessment and discussion of research trends in ocean acoustics	Week 14	Summary lecture, Q&A, presentation of final insights	Final Exam / Presentation (60%)	CLO 4

PART C

13) **Assessment and Evaluation**

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	2		2	10
Understand		1	2	1	3	10
Apply	**5**	1	2	1	2	15
Analyze		1	2	1	3	15
Evaluate		1		1	2	5
Create			2	1	3	5

PART D

Prescribed Textbooks:

1. Frisk, George V. *Ocean and Seabed Acoustics: A Theory of Wave Propagation*. Prentice Hall, 1994. ISBN: 9780136301127.
2. Jensen, F. B., Kuperman, W. A., et al. *Computational Ocean Acoustics*. Springer, 2011. ISBN: 9781441986771.
3.

Recommended References:

1. Brekhovskikh, L. M., & Lysanov, Yu. P. *Fundamentals of Ocean Acoustics*. Springer, 2010. ISBN: 9781441930156.
2. Katsnelson, B. G., & Petnikov, V. G. *Shallow Water Acoustics*. Springer, 2002. ISBN: 9781852331849.
3. Katsnelson, B. G., Petnikov, V. G., & Lynch, J. *Fundamentals of Shallow Water Acoustics*. Springer, 2012. ISBN: 9781441997760.
4. Medwin, H., & Clay, C. S. *Fundamentals of Acoustical Oceanography*. Academic Press, 1997. ISBN: 9780124875708.
5. Ogilvy, J. A. *Theory of Wave Scattering From Random Rough Surfaces*. Taylor & Francis, 1991. ISBN: 9780750300636.
6. Aster, R., Borchers, B., & Thurber, C. *Parameter Estimation and Inverse Problems*. Academic Press, 2005. ISBN: 9780120887927.
7. Medwin, H. *Sounds in the Sea: From Ocean Acoustics to Acoustical Oceanography*. Cambridge University Press, 2005. ISBN: 9780521829502.
8. Menke, W. *Geophysical Data Analysis: Discrete Inverse Theory*. Academic Press, 1989. ISBN: 9780124909212.

Course Title: Water Science & Resources Management	
Course Code: OCN 3113	**Credit: 3.0**

PART A

1) **Course Code:** OCN 3113

2) **Course Title:** Water Science & Resources Management

3) **Course Type:** Core Course

4) **Year and Semester:** Year 3, Semester 1

5) **Prerequisite (if any):** N/A

6) **Credit Value:** 3

7) **Contact Hours:** 42

8) **Total Marks:** 100

9) **Course Summary and Objectives:**

This course provides a comprehensive overview of water science and resources management, a process that promotes the coordinated development and management of water, land, and related resources to maximize economic and social welfare in an equitable manner, without compromising the sustainability of vital ecosystems. Students will explore the principles, challenges, and practical applications of water resources management, focusing on its relevance to oceanography, coastal management, and sustainable water usage. The course also emphasizes the interconnections between water, land, and socio-economic factors, along with the evaluation of different approaches to sustainable water management.

Objectives:

- ✓ To understand the fundamental concepts of the occurrence and movement of water in nature
- ✓ To understand the components of the water cycle and their interrelationships
- ✓ To explore freshwater, saline water resources in the coastal regions
- ✓ understand the importance of water as a resource, from a human perspective and in terms of the natural environment;
- ✓ understand the hydro-meteorological hazards i.e., floods, storm surges, droughts, saline water intrusion, etc.

10) **Course Learning Outcomes (CLO):**

- **CLO 1:** understand basic principles of the occurrence, distribution and movement of water on the earth and explain the processes and role of different components involved in the water cycle

- **CLO 2**: Understand the principles and concepts of water science and resources management, and apply these concepts to oceanography and coastal management.
- **CLO 3**: Identify key challenges and opportunities in water resource management at various scales, from local to global.

- **CLO 4**: Analyse the interconnections between water, land, environment, and socio-economic factors in the management of water resources.
- **CLO 5**: Evaluate different approaches, tools, and strategies for sustainable water management, including policy and governance frameworks.
- **CLO 6**: Apply IWRM principles to coastal watershed and estuarine systems.

11) **Mapping of CLOs with Program Learning Outcomes (PLOs):**

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	3	3	3	3	3	3	2	2	3	3
CLO 2	3	2	3	3	2	2	3	1	3	2
CLO 3	2	3	2	3	1	2	3	1	3	2
CLO 4	3	2	3	3	2	3	2	1	3	2
CLO 5	3	3	2	3	2	3	2	2	3	3

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) **Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques**

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	**Introduction to Water Science and Resources Management**: distribution of water, Hydrologic cycle and its components, Global Water Budget Definition and evolution of water science and resources management. Key principles and objectives of water resources management. Challenges in water management: scarcity, pollution, climate change, population growth. Introduction and Basic concept of watershed, Quantitative Evaluation of Watershed	Week-1	Lecture, Discussion	Assignment on the evolution and principles of water resources management	CLO 1
2	**Basics of Hydrological Processes:** precipitation, Types of precipitation, and Forms of precipitation Measurement of precipitation, Estimation of Infiltration. Surface run-off, Streamflow basics, Components, Effects, Estimation Factors Affecting Evaporation, Evaporation Reduction from Water Surface. Evaporation & Transpiration	Week-2 Week-3	Lecture	Quiz on hydrological processes and water management techniques	CLO 2

	Processes, Evapotranspiration (ET), Estimation, Streamflow basics. Streamflow Velocity; River-Stage and Discharge, Instrumentation, Field techniques of measurement.				
3	**Groundwater Hydrology:** Groundwater Occurrence and Distribution, role of groundwater in hydrologic cycle, Origin, Occurrence and distribution of Groundwater, Exploring the interconnectedness of water resources. Understanding porosity, permeability, specific yield, and specific storage. Visualizing saturated and unsaturated zones. The dynamic water table: factors influencing its fluctuations; Aquifer Types and Characteristics: Delving into the characteristics of confined, unconfined, perched, and fractured aquifers. Mapping and interpreting hydrogeological units; recharge and discharge.	Week-4 Week-5	Lecture, Hands-on Analysis		CLO 1 CLO 2 CLO 3
4	**Coastal hydrologic Processes:** • Coastal zone dynamics • Estuarine hydrology • Coastal Aquifers and Saltwater Intrusion • Influence of tide • Fresh water-salt water interaction: Exploring the dynamic connections between surface water and groundwater. • Hydrological problems in coastal regions, Causes and Impacts; • Understanding gaining and losing streams. The vital role of the hyporheic zone.	Week-6 Week 7	CT-1 Class Lectures, Discussions, Interactive sessions		CLO 1 CLO 2 CLO 3
5	**Water Quality Management:** Sources and types of water pollution (point and non-point sources). Water quality parameters and standards. Wastewater treatment and reuse.	Week-8	Lecture, Discussion	Lab report on water quality management practices	CLO 3
6	**Mid Term Examination** Eutrophication and its impacts on aquatic ecosystems. Monitoring and assessment of water quality.	Week-9	- Lecture, Discussion	- Lab report on water quality management practices	- CLO 1 CLO 2 CLO 3
7	**Freshwater Ecosystems**: Importance of aquatic ecosystems (rivers, lakes,	Week-10	Lecture, Discussion		CLO 4

	wetlands, estuaries, coastal zones). Ecological water requirements and environmental flows. Impacts of human activities on water-dependent ecosystems. Ecosystem-based approaches to water management.				
8	**Water Resources Management**: • Water demand and supply • Water economics: valuation of water, water pricing, cost-benefit analysis. • Water for food, energy, and industry. • Water and health: water-borne diseases, sanitation. • Water conflicts and cooperation. • Transboundary Water Resources	Week-11	Lecture, Case Study	Case study on ecosystem-based water management	CLO 3
9	**Governance, Policy, and Legal Frameworks in Water Management:** • Institutional arrangements for water management. • Water policies and legislation at national and international levels. • Stakeholder participation and public engagement. • Transboundary water management and international water law.	Week-12	Lecture, Practical Exercises	Research paper on water economics and socio-economic impacts	CLO 5
10	**Introduction to IWRM:** • Concepts and Global Practices • Keys and Challenges, • Policy Instruments in IWRM (Legal, Institutional, Financial Tools), • Climate Change Adaptation in Coastal IWRM in Bangladesh	Week 13		Class test on governance and legal frameworks	CLO 5 CLO 6
11	**Tools and Approaches for Water Management Implementation:** • Decision support systems and modelling in water management. • Geographic Information Systems (GIS) and remote sensing for water resources. • Case studies of successful water management implementation globally and regionally.	Week 14	Lecture, Student Presentation	Lab work on GIS and remote sensing for water management	CLO 6

PART C

13) **Assessment and Evaluation**

Bloom's Category	Continuous Internal Evaluation					Semester Final Examination
	Attend. (05)	Class Performance (05)	Class Tests (10)	Assign. (05)	Mid Term (15)	Final (60)
Remember		1	2		2	10
Understand		1	2	1	3	10
Apply	**5**	1	2	1	2	15
Analyze		1	2	1	3	15
Evaluate		1		1	2	5
Create			2	1	3	5

PART D

Reference Books:

1. Pahl-Wostl, C. (2007). *Integrated Water Resources Management: Principles, Cases, and Challenges*. Springer.
2. Mays, L. W. (2004). *Water Resources Management*. McGraw-Hill.
3. Dingman, L. (2014) Physical Hydrology (3rd Edition). Waveland Press, Inc.
4. Hornberger et.al. (2014) Elements of Physical Hydrology (2nd Edition). JHU Press
5. Shaw, E. M., Beven, K. J., Chappell, N. A., & Lamb, R. (2010) Hydrology in Practice (4th Edition). CRC Press.
6. Raghunath, H.M. (1987) Groundwater. New Age International.
7. Chow, V.T. (1964) Handbook of Applied Hydrology. McGraw-Hill.
8. Meinzer, O. E. (1949) Hydrology. Dover Publications.
9. Wisler, C.O. & Brater, E.F. (1959) Hydrology. John Wiley & Sons Inc.
10. Chow, V. T., David R. Maidment, and Larry W. Mays (1988). Applied hydrology.
11. Herschy, R. W. (2008). Streamflow measurement. CRC press.
12. Singh, V. P., & Xu, Y. J. (2006). Coastal Hydrology and Processes. Colorado: Water Resources Publications LLC, 465-479.
13. Philip B. Bedient, Wayne C. Huber, and Baxter E. Vieux (?). Hydrology and Floodplain Analysis.

Detail Syllabus Sixth Semester
(Year-3, Semester-2)

Course Title: Geophysical Fluid Dynamics	
Course Code: OCN 3201	**Credit:3.0**

PART A

1) Course Code: OCN 3201

2) Course Title: Geophysical Fluid Dynamics

3) Course Type: CC

4) Year and Semester: Year 3, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course provides an introduction to the fundamental principles of geophysical fluid dynamics (GFD), focusing on the large-scale motion of fluids on rotating planets, particularly Earth's atmosphere and oceans. Topics include the effects of rotation and stratification, conservation laws, geostrophic balance, shallow water equations, and an introduction to waves and instabilities relevant to geophysical flows. The course aims to develop a theoretical understanding of the dynamics governing climate and ocean circulation and equip students with the ability to solve GFD problems both analytically and numerically.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Understand the influence of planetary rotation and stratification on fluid motion and its significance for Earth and Ocean sciences.
ii. **CLO 2:** Derive and interpret the governing equations for geophysical flows, including the effects of rotation and stratification.
iii. **CLO 3:** Analyze and apply concepts of geostrophic and hydrostatic balance in large-scale ocean and atmospheric circulation.
iv. **CLO 4**: Identify and characterize different types of waves and instabilities in geophysical fluids, with a focus on large-scale circulation and climate dynamics.
v. **CLO 5**: Solve simplified GFD problems analytically and numerically using appropriate methods.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	3	3	3	3	3	3	2	2	3	3
CLO 2	3	2	3	3	2	2	3	1	3	2
CLO 3	2	3	2	3	1	2	3	1	3	2
CLO 4	3	2	3	3	2	3	2	1	3	2
CLO 5	3	3	2	3	2	3	2	2	3	3

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	**Introduction to Geophysical Fluid Dynamics (GFD):** Definition and scope of GFD. Scales of motion in the atmosphere and ocean. Review of basic fluid mechanics concepts: Eulerian and Lagrangian descriptions, continuity equation. Importance of rotation and stratification in geophysical flows.	Week-1-2	Lecture, Discussion	Assignment on the role of GFD in Earth and Ocean Sciences	CLO 1
2	**Equations of Motion on a Rotating Earth:** Newton's Second Law in a rotating frame of reference. Coriolis force and its effects. Apparent forces: centrifugal and Coriolis. Derivation of the Navier-Stokes equations in a rotating frame.	Week-3-4	Lecture, Group Discussion	Quiz on the equations of motion in a rotating frame	CLO 2
3	**Geostrophic and Hydrostatic Balance:** Concept of geostrophic	Week-5	Lecture, Problem Solving	Class test on geostrophic	CLO 3

	balance in the ocean and atmosphere. Thermal wind relation. Hydrostatic balance and its implications for vertical structure. Geostrophic currents and their calculation from density fields.			and hydrostatic balance	
4	**Vorticity Dynamics:** Concept of vorticity and circulation. Potential vorticity conservation. Rossby waves: properties and importance in large-scale circulation. Planetary beta-effect.	Week-6	Lecture, Case Study	Lab work on vorticity and circulation	CLO 4
5	**Shallow Water Equations:** Derivation of the shallow water equations. Linearized shallow water equations.	Week-7	Lecture, Problem Solving	Class test on shallow water equations and wave dynamics	CLO 2, CLO 5
6	**Mid-term Examination** Gravity waves in shallow water. Kelvin waves and their role in coastal and equatorial dynamics.	- Week-8	- Lecture, Problem Solving	- Assignment on ocean circulation and gyres	- CLO 2, CLO 5
7	**Large-Scale Ocean Circulation:** Wind-driven circulation: Ekman transport, Sverdrup theory. Western boundary currents (e.g., Gulf Stream, Kuroshio). Thermohaline circulation: deep water formation, global conveyor belt. Ocean gyres and their dynamics.	Week-9-10	Lecture, Group Discussion	Assignment on ocean circulation and gyres	CLO 3
8	**Large-Scale Atmospheric Circulation:** Hadley, Ferrel, and Polar cells. Jet streams. Monsoons and their dynamics. Atmospheric fronts and cyclones (brief introduction).	Week-11-12	Lecture, Case Study	Research paper on atmospheric circulation patterns	CLO 3

9	**Waves and Instabilities in Geophysical Fluids:** Internal gravity waves. Inertial oscillations. Barotropic and baroclinic instabilities. Introduction to El Niño-Southern Oscillation (ENSO) as an example of coupled ocean-atmosphere dynamics.	Week-13-14	Lecture, Problem Solving	Project work on waves and instabilities	CLO 4, CLO 5

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	2		2	10
Understand		1	2	1	3	10
Apply	**5**	1	2	1	2	15
Analyze		1	2	1	3	15
Evaluate		1		1	2	5
Create			2	1	3	5

PART D

Reference Books:

6. Marshall, J., & Plumb, R. A. (2008). *Atmosphere, Ocean and Climate Dynamics: An Introductory Text*. Academic Press.
7. Pedlosky, J. (2013). *Geophysical Fluid Dynamics*. Springer.
8. Cushman-Roisin, B., & Beckers, J.-M. (2011). *Introduction to Geophysical Fluid Dynamics*. Academic Press.

Course Title: Hydrography	
Course Code: OCN 3203	**Credit: 3.0**

PART A

1) Course Code: OCN 3203

2) Course Title: Hydrography

3) Course Type: Core Course

4) Year and Semester: Year 3, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course introduces students to the principles and practices of hydrography with a focus on practical applications in marine mapping, navigation, engineering, and environmental monitoring. Students will develop an understanding of tidal and current phenomena, seafloor mapping technologies, and the use of hydrographic data for maritime and coastal projects. Course objectives include –

- To understand the basic concepts, scope, and applications of hydrography.
- To learn the principles and techniques of hydrographic surveying and data acquisition.
- To explore the use of positioning systems, sonar technologies, and GIS in hydrographic operations.
- To apply hydrographic knowledge in engineering, navigation, and resource management contexts

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Explain the principles and significance of hydrography and identify its maritime applications.
ii. **CLO 2:** Describe and evaluate hydrographic surveying tools and data acquisition systems including sonar, GNSS, and sensors.
iii. **CLO 3:** Apply knowledge of tides, currents, and oceanographic variables in hydrographic contexts.
iv. **CLO 4:** Demonstrate skills in interpreting hydrographic data using GIS and supporting tools for marine projects.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	**3**	1	1	1	1	1	**3**	**3**	2
CLO 2	**3**	**3**	**3**	**3**	1	1	2	**1**	**3**	3

CLO 3	**3**	**3**	**3**	**3**	2	1	2	**1**	**3**	2
CLO 4	**3**	**3**	**3**	**3**	2	1	2	**3**	**3**	**3**

(Weightage: 3-High, 2-Medium, 1-Low)

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1)	Introduction to Hydrography: scope, applications, and significance	Week 1	Lecture, case-based discussion	Class participation	CLO 1
2)	Hydrographic Surveying Techniques: depth measurement, positioning, controls	Week 2	Board work, equipment demos	Assignment	CLO 2
3)	Tides and Currents: theory, observation, prediction	Week 3	Problem solving, tide tables	Quiz	CLO 3
4)	GNSS and Positioning Systems	Week 4	Practical maps, real-time positioning	Class Test	CLO 2
5)	Single Beam & Multibeam Echo Sounders: principles, data collection	Week 5	Case studies, simulation tools	Assignment	CLO 2
6)	Side Scan Sonar: operation, image interpretation	Week 6	Imagery analysis, field case examples	Quiz	CLO 2
7)	**Mid-Term Examination** Introduction to AUV, ROV.	Week 7	— Lecture, case-based discussion	Mid-Term Exam (15 marks)	— CLO 2
8)	Physical Oceanography: salinity, temperature, pressure, tides, and currents	Week 8	Graphs, CTD data samples	Quiz	CLO 3
9)	Hydrographic Data Acquisition: acoustic/motion sensors, transducers, automated hydrographic surveys.	Week 9	Equipment handling, manufacturer specs	Assignment	CLO 2
10)	Non-Acoustic Systems and Sensors	Week 10	Discussion, sensor calibration insights	Homework	CLO 2

11)	Hydrographic Information Systems and GIS	Week 11	Software tutorial, data layering tasks	Short written task	CLO 4
12)	Survey planning and reconnaissance	Week 12	Simulation, team-based map planning	Group project plan	CLO 4
13)	Hydrographic Surveying for Coastal Engineering Projects	Week 13	Application examples, dredging reports	Assignment	CLO 4
14)	Review and Viva	Week 14	Q&A, synthesis of methods	Viva (15 marks)	CLO 1–4

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	2		2	10
Understand		1	2	1	3	10
Apply	5	1	2	1	2	15
Analyze		1	2	1	3	15
Evaluate		1		1	2	5
Create			2	1	3	5

PART D

16) Textbook:

- Calderbank, R. (2014). *Hydrographic Surveying*. UKHO Publications.

17) Reference Books:

- International Hydrographic Organization (IHO). *Manual on Hydrography*.
- Wright, D. & Bartlett, D. (2001). *Marine and Coastal Geographical Information Systems*. Taylor & Francis.
- Sharma, R. C. (2016). *Oceanographic Instrumentation: Principles and Applications*. CRC Press.
- US Army Corps of Engineers. *Hydrographic Surveying Engineer Manual*.

Course Title: Hydrography Lab	
Course Code: OCN 3204	**Credit: 1.5**

Part A

1) Course Code: OCN 3204

2) Course Title: Hydrography Lab

3) Course Type: SKD

4) Year and Semester: Year 3, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 1.5

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This practical course is designed to provide students with hands-on experience in hydrographic survey planning, data acquisition, and processing using modern equipment and software. Students will gain familiarity with tools like GNSS receivers, single and multibeam echo sounders, side scan sonar, and GIS-based hydrographic analysis. Course objectives include –

- To provide operational knowledge of hydrographic instruments including GNSS, echo sounders, and sonar.
- To develop practical skills in data collection, processing, and quality control for bathymetric surveys.
- To expose students to real and simulated field conditions through project-based learning.
- To interpret and visualize hydrographic data using modern software tools.

10) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	3	3	3	3	3	2	3	2	2	1
CLO 2	3	3	3	3	3	2	2	3	3	2
CLO 3	3	3	3	3	3	2	3	3	2	2
CLO 4	3	3	3	3	3	2	3	3	3	3

(Weightage: 3-High, 2-Medium, 1-Low)

Part B

11) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1)	Introduction to Hydrography (equipment overview and applications)	Week 1	Demonstration, lab orientation	Class participation	CLO 1
2)	Horizontal and vertical control, GNSS theory and setup	Week 2	GNSS equipment handling, outdoor demo	Quiz	CLO 1
3)	Depth measurement: Single beam echo sounder	Week 3	Device setup, data logging, SBES software	Assignment	CLO 1
4)	Multibeam echo sounder (MBES) theory and practical demo	Week 4	MBES simulator, coverage comparison	Report	CLO 1, CLO 2
5)	Side scan sonar image collection and interpretation	Week 5	Image analysis, angle adjustment	Class test	CLO 2
6)	Tide and current measurement setup and retrieval	Week 6	Tide gauge deployment, CTD profiles	Assignment	CLO 2
7)	Class Test (Instrument Identification + Methods)	Week 7	Practical-based assessment	Class Test (15 marks)	—
8)	Data collection campaign (simulated or field)	Week 8	Team-based fieldwork/data simulation	Participation + raw dataset	CLO 2
9)	Data processing: cleaning, gridding, formatting	Week 9	Software walkthrough (e.g., HYPACK, QPS)	Assignment	CLO 2
10)	Usage of AUV and ROV	Week 10	AUV data examples, ROV demonstration	Demonstration	CLO 3
11)	GIS and hydrographic information system (HIS) integration	Week 11	ArcGIS/QGIS operations, overlays	Map interpretation task	CLO 3

12)	Final project planning and dataset selection	Week 12	Topic selection, data scouting	Project outline submission	CLO 4
13)	Final project analysis, mapping, and interpretation	Week 13	Independent work, instructor feedback	Draft map submission	CLO 4
14)	Viva and project presentation	Week 14	Oral defense + visual presentation	Viva	CLO 4

PART C

12) Assessment and Evaluation

Bloom's Category	Continuous Internal Evaluation				Semester Final Examination
	Attend. (10)	Class Performance (10)	Viva/Presentation (20)	Assignment /Lab report (20)	Final (40)
Remember		02	05		05
Understand		02	10	03	05
Apply	10	02		02	05
Analyze		02		05	10
Evaluate		02	05	10	05
Create					10

PART D

13) Textbook:

- Calderbank, R. (2014). *Hydrographic Surveying*. UKHO Publications.

14) Reference Materials:

- International Hydrographic Organization (IHO). *Manual on Hydrography*.
- Wright, D. & Bartlett, D. (2001). *Marine and Coastal Geographical Information Systems*.
- Sharma, R. C. (2016). *Oceanographic Instrumentation: Principles and Applications*.
- US Army Corps of Engineers. *Hydrographic Surveying Manual*.
- Manuals of GNSS, SBES, MBES, and SSS equipment used during lab.

Course Title: GIS and Remote Sensing	
Course Code: OCN 3205	**Credit: 3.0**

1) Course Code: OCN 3205

2) Course Title: GIS and Remote Sensing

3) Course Type: FC

4) Year and Semester: Year 3, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Description: This course introduces students to the fundamental principles and applications of remote sensing and Geographic Information Systems (GIS). Students will learn about the principles of remote sensing data acquisition, processing, and analysis, and the core concepts and applications of GIS.

Objectives:

Upon successful completion of this course, students will be able to:

- Understand the principles of electromagnetic radiation and its interaction with Earth's surface.
- Describe different types of remote sensing platforms (aerial, satellite, airborne).[1]
- Analyze different types of remote sensing data (e.g., aerial photographs, satellite imagery, radar).
- Apply basic image processing techniques (e.g., image enhancement, classification, change detection).
- Understand the components of a GIS and its basic functions.
- Work with different types of spatial data (raster, vector).[2]
- Perform basic GIS operations (e.g., data entry, editing, query, analysis).
- Create and interpret maps using GIS software.
- Application of remote sensing and GIS techniques to solve real-world problems (e.g., mapping, mineral exploration, natural hazard assessment).[3]
- Understand the applications of remote sensing and GIS in environmental monitoring and management.
- Explore the use of remote sensing and GIS in other fields (e.g., agriculture, forestry, urban planning).

10) Course Learning Outcomes (COs):

At the end of the course the students will be able to:

i. **CLO1:** Understand the basic principles of remote sensing including electromagnetic radiation, sensor types and satellite systems
ii. **CLO2:** Interpret and analyze remotely sensed imagery to extract meaningful geospatial information
iii. **CLO3:** Understand the fundamentals of Geographic Information System (GIS) and spatial data structures (raster and vector)
iv. **CLO4:** Apply image processing techniques such as classification, enhancement and filtering perform spatial analysis and modeling using GIS tools to solve real world problems
v. **CLO5:** Apply basic procedure of thematic mapping and effectively communicate geospatial findings through maps

11) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

PLO	**PLO 1**	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PLO 10**
CLO 1	**3**	**3**	2	2	1	1	1	2	**3**	2
CLO 2	**3**	**3**	**3**	**3**	1	1	1	2	**3**	**3**
CLO 3	**3**	**3**	2	**3**	1	1	1	2	2	**3**
CLO 4	**3**	**3**	**3**	**3**	2	1	2	2	**3**	**3**
CLO 5	**3**	**3**	2	**3**	2	1	2	2	**3**	**3**

PART B

11) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	**Course Contents**		**Time Frame**	**Teaching Strategies**	**Assessment Strategies**	**Alignment with CLOs**
1	Introduction to Remote Sensing	Principles of remote sensing, Electromagnetic spectrum	Week -1	Lecture, Discussion	Assignment	CLO 1
2	Remote Sensor and Platform	Remote Sensing Platforms, Scanner, Types of	Week -2			

		remote sensor, satellite remote sensing				
3	Remote Sensing Data Acquisition	Data Acquisition system of Active, Passive and Hyper spectral remote sensing; Geometric and Radiometric distortion of image Remote Sensing of rocks, Minerals and Vegetation Spectral mapping of rocks, minerals and vegetation	Week -3	Lecture, Discussion, Video Presentation	Class performance and interactions	CLO 1, CLO 3
5	Image Interpretation Techniques	Visual Image interpretation, digital image processing Image enhancement Contrast enhancement, filtering, noise reduction, band rationing etc. Image Classification: Supervised and unsupervised classification techniques	Week -4 Week 5	Lecture, Group Discussion	Class Test/Quiz-1	CLO 2, CLO 3
6	Aerial photography And Photogrammetry	Principles of aerial photography; Acquisition, aerial photograph and interpretation techniques Principles of photogrammetry; Acquisition of Photogrammetry image and interpretation techniques	Week 6			

7	LiDAR(Light Detection and Ranging) and Microwave Remote Sensing	Principles of LIDAR; Acquisition LIDAR image and interpretation techniques; Concept, microwave EMR system, RADAR and	Week 7	Interactive discussion, whiteboard illustration	Presentation, interactions	CLO 1, CLO 3
8	Mid-Term Examination	- InSAR sensor resolution, application of microwave remote sensing	 Week - 8	- Interactive discussion, whiteboard illustration	- Presentation, interactions	- CLO 1, CLO 3
9	Introduction to GIS	Definition and evolution of GIS -Components: Hardware, Software, Data, People, Methods Key functions: Data capture, storage, analysis, visualization Applications in urban planning,disaster management, environmental monitoring	Week -9	Interactive discussion, whiteboard illustration		CLO 2, CLO 4
12	Current Trends and Approaches	Evolution from traditional GIS to modern GIS platforms Cloud GIS and Web GIS Integration with AI, Big Data, and IoT Mobile GIS and real-time data analytics Role of Open Source GIS	Week -9	PowerPoint presentation, whiteboard illustration, discussions on mid-term scripts	Sketching the diagrams	CLO 2, CLO 4
`13	Map Projection and	Basics of map projections and	Week -9	Lecture, Discussion	Class Test/Quiz-	CLO 4

	Coordinate Systems	distortions (shape, area, distance, direction) Types of projections: Cylindrical, Conical, Azimuthal Coordinate systems: Geographic (lat/long), Projected (UTM) -Datum concepts and transformation techniques			2	
14	Vector Data Model	Concepts: Points, Lines, Polygons and their real-world representations Topology rules: Connectivity, Contiguity, Adjacency Georelational Data Model: Linking spatial and attribute data through unique IDs (e.g., Shapefiles) Object-Based Data Model: Treating spatial features as objects with properties and behaviors (e.g., Geodatabases) Comparison of Georelational vs. Object-Based Models: Structure, storage, performance Advantages and limitations of vector data for spatial analysis	Week 10	Lecture, Discussion		CLO 1, CLO 3
15	Raster Data	Definition and	Week	Lecture,		CLO 1,

	Model	characteristics of raster data Cell size, resolution, and data storage formats Raster vs. Vector comparison Common raster data: Satellite images, DEMs, Land cover maps	11	independent reading		CLO 3 CLO 5
16	Geometric Transformation	Importance of Geometric corrections Transformation methods: Affine, Polynomial, Projective Root Mean Square (RMS) error analysis Image registration and resampling techniques	Week 11	Lecture, Discussion	Class Test/Quiz-2	CLO 4
17	Attribute Data Management	Attribute tables: Fields, records, data types (text number, date) Database management: Joins, relates, normalization Querying data: SQL basics, selection by attributes Data visualization through attribute-driven symbology	Week 11	Lecture, Discussion		CLO 1, CLO 3
18	GIS Data Acquisition	Primary and Secondary data sources Remote sensing and GPS data collection Public GIS data	Week 11	Lecture, independent reading		CLO 1, CLO 3

		portals and open-source datasets Data quality considerations: Accuracy, precision, metadata				
19	Data Input	Methods: Manual digitizing, scanning, importing shapefiles, geocoding Error checking, data cleaning, and validation Coordinate systems and data alignment during input Best practices for efficient data entry	Week 11	Lecture, Discussion	Class Test/Quiz-2	CLO 4
20	Cartography and Map Design	Principles of Effective cartography Map elements: Title, legend, scale, north arrow, grid, labels Symbolization, color theory, and visual hierarchy Map layout design for different purposes (thematic, topographic)	Week -12	Lecture, Discussion		CLO 1, CLO 3
21	Vector Data Analysis	Spatial analysis techniques: Buffering, overlay (union, intersect), Dissolve Proximity analysis and spatial queries Network analysis basics: Shortest path, service area	Week 13	Lecture, independent reading		CLO 1, CLO 3

		Real-world applications: Site selection, risk mapping				
22	Raster Data Analysis	Raster operations: Reclassification, Raster calculator, Map algebra Overlay analysis with raster data Zonal statistics for summarizing spatial data Applications: Land use change detection, environmental modeling				
23	Terrain and Watershed Analysis Neighborhood Analysis	- Digital Elevation Models (DEM): Slope, aspect, Hillshade analysis Watershed delineation: Flow direction, accumulation, stream network extraction Hydrological mo Watershed delineation: Flow direction, accumulation, stream network extraction Hydrological modeling concepts and flood risk analysis deling concepts and flood risk analysis Concept of neighborhood operations in	Week 14	Lecture, independent reading		

		raster GIS Focal statistics: Mean, median, maximum, etc. Moving window analysis for spatial smoothing Applications: Hotspot detection, land suitability modeling				

PART C

15) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	2		2	10
Understand		1	2	1	3	10
Apply	**5**	1	2	1	2	15
Analyze		1	2	1	3	15
Evaluate		1		1	2	5
Create			2	1	3	5

PART D

Recommended References:

- Jensen, J.R. (2014) Remote Sensing of the Environment: An Earth Resource Perspective (Pearson New International Edition). Pearson.
- Longley, P.A., Goodchild, M.F., Maguire, D.J., Rhind, D.W. (2015) Geographic Information Science

Course Title: GIS and Remote Sensing Lab	
Course Code: OCN 3206	Credit: 1.5

PART A

1) Course Code: OCN 3206

2) Course Title: GIS and Remote Sensing Lab

3) Course Type: SKD

4) Year and Semester: Year 3, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 1.5

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

Course Description: This advanced laboratory courses focuses on the application of remote sensing and GIS techniques to solve complex problems. Students will gain hands-on experience with image processing, spatial analysis, and geospatial modeling using industry-standard software.

Course Learning Objectives:

Upon successful completion of this course, students will be able to:

- Image Processing:
  - Understand the fundamental principles of remote sensing and GIS.
  - Develop proficiency in using remote sensing and GIS software (e.g., ArcGIS, ERDAS Imagine, and Google Earth Engine).
  - Apply remote sensing and GIS techniques to solve geological problems.
  - Interpret and analyze remote sensing imagery and spatial data.
  - Create thematic maps and spatial models relevant to geological applications.
  - Perform advanced image processing techniques (e.g., image classification, object-based image analysis, change detection).
  - Apply image rectification and orthorectification techniques.
  - Utilize spectral indices and other image enhancement methods.
- GIS Analysis:
  - Perform spatial interpolation techniques to predict unknown values
  - Perform various geoprocessing to be able to execute spatial analysis
  - Perform advanced spatial analysis operations (e.g., network analysis, surface analysis, 3D modeling).
  - Integrate remote sensing data with other geospatial datasets (e.g., DEMs, geological maps).
  - Develop and implement geospatial databases.

- Geospatial Modeling:
    - Develop and implement simple geospatial models (e.g., slope stability models, groundwater models).
    - Integrate remote sensing and GIS data into geospatial models.

10) Course Learning Outcomes (CLOs):

i. **CLO 1:** Understand basic concepts of Remote Sensing and GIS technologies- recognize satellite image types, sensors and resolutions
ii. **CLO 2:** Perform image processing and enhancement techniques- applying filtering, classification of remotely sensed images
iii. **CLO 3:** Analyzing spatial data using GIS tools and conduct spatial analysis like buffering, overlaying and spatial queries
iv. **CLO 4:** Prepare thematic maps and reports- design maps with appropriate symboloby, scales and legends
v. **CLO 5:** Interpret satellite imagery for real world applications- identify land use/land cover, vegetation indices, water bodies etc.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	3	3	2	3	3	3	3	3	3	3
CLO 2	3	3	3	3	3	2	2	3	3	3
CLO 3	3	3	2	3	3	3	3	3	3	3
CLO 4	3	3	2	3	3	2	2	3	3	3
CLO 5	2	3	2	3	3	2	2	3	3	3

(Weightage: 3-High, 2-Medium, 1-Low)

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents		Time Frame	Teaching Strategies	Assessment Strategies	Align-ment with CLOs
1.	Introduction to Image	Introduction to ArcGIS/ERDAS Imagine remote sensing modules. Image display.	Week-1	Lecture, Discussion	Assignment	CLO 1
2.	Satellite Image Acquisition and visualization in	Learning the acquisition of remote sensing from both specific satellite sensor's	Week-2	Lecture, Discussion	Assignment	CLO 1

	Software.	image and using spectroradiometer in field.				
3.	Spectral Properties of Earth Materials	Spectral reflectance curves of rocks, minerals, soils, and vegetation using Spectroradiometer. Spectral libraries and their applications. Introduction to spectral indices	Week-3	Lecture, Discussion, Video Presentation	Class performance and interactions	CLO 1, CLO 3
4.	Geometric Correction and Image Registration	Geometric distortions and their sources. Ground control points (GCPs) and rectification. Image registration and mosaicking	Week-4 Week 5	Lecture, Group Discussion	Class Test/Quiz-1	CLO 2, CLO 3
5.	Image Classification (Unsupervised) and accuracy assessment	Principles of unsupervised classification (e.g., k-means). Accuracy assessment methods (e.g., confusion matrix).	Week 6			
6.	Image Classification (Supervised)	Principles of supervised classification. Training sample selection and signature generation. Classification algorithms (e.g., maximum likelihood), AI/ML for image classification.	Week 7 - Week 8	Interactive discussion, whiteboard illustration	Presentation, interactions	CLO 1, CLO 3
7.	Introduction to GIS and Spatial Data	GIS concepts and applications. Vector and raster data models. Coordinate systems and projections	Week-9			
8.	GIS Software and Data Input	Introduction to ArcGIS. Familiarization of various component of ArcGIS software Digitizing vector data. Georeferencing raster data.	Week 10	Interactive discussion, whiteboard illustration		CLO 2, CLO 4
9.	Digital Elevation Models (DEMs) and Applications	Sources of DEM data (SRTM, LiDAR). DEM processing and analysis. Applications in geomorphology and hydrology.	Week 11	PowerPoint presentation, whiteboard illustration, discussions on mid-	Sketching the diagrams	CLO 2, CLO 4

				term scripts		
10.	Introduction to GPS and Field Data Collection	GPS principles and applications. Field data collection using GPS. Integration of GPS data with GIS.	Week-12	Lecture, Discussion	Class Test/Quiz-2	CLO 4
11.	Environmental impact assessment.	Monitoring environmental changes through spectral curve using spectroradiometer. Land use/land cover change detection.	Week 13	Lecture, Discussion		CLO 1, CLO 3 CLO 5
12.	Introduction to Google Earth Engine	Cloud based remote sensing. Accessing and processing large datasets. Scripting in Google Earth Engine.	Week-14	Lecture, independent reading		CLO 1, CLO 3 CLO 5

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1				10
Understand		1	3		3	10
Apply	**5**	1	3		5	10
Analyze		1	2	3	5	10
Evaluate		1	2	2	2	10
Create						10

PART D

Recommended References:

- Jensen, J.R. (2014) Remote Sensing of the Environment: An Earth Resource Perspective (Pearson New International Edition). Pearson.
- Longley, P.A., Goodchild, M.F., Maguire, D.J., Rhind, D.W. (2015) Geographic Information Science & System (4th Ediiton). Wiley.

- Kennedy, M. (2013) Introducing Geographic Information Systems with ArcGIS. A Workbook Approach to Learning GIS (3rd Edition). Wiley.
- Heywood, I., Cornelius, S., Carver, S. (2006) An Introduction to Geographical Information Systems (3rd Edition). Pearson Prentice Hall.
- Jensen, J.R. (2004) Introductory Digital Image Processing: A Remote Sensing Perspective (3rd Edition). Prentice Hall.
- Lillesand, T.M., Kiefer, R.W. and Chipman, J.W. (2004) Remote Sensing and Image Interpretation (5th Edition). John Wiley and Sons.
- Clarke, K.C., (2003) Getting Started with Geographic Information System (4th Edition). Prentice Hall. Bonham-Carter, G.F. (1994) Geographic Information Systems for Geoscientists: Modeling with GIS. Elsevier Science Publications.

Course Title: Research Methodology	
Course Code: OCN 3207	Credit: 2.0

PART A

1) Course Code: OCN 3207

2) Course Title: Research Methodology

3) Course Type: RC

4) Year and Semester: Year 3, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 2

7) Contact Hours: 28

8) Total Marks: 100

9) Course Summary and Objectives:

This course is designed to help the students understand the basic concepts of research and its methodologies. To carry out oceanography research the students have to learn about the fundamentals of research methodology. 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.

Course objectives include –

- To learn the basic concepts of research, types, methods, processes and so on
- To know way of designing research plan
- To learn sampling strategies and data collection methods
- To know how to check the accuracy of result and present research findings

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Learn about the fundamental concepts and related ideas of research methodology
ii. **CLO 2:** Design research plan
iii. **CLO 3:** Collect data using various techniques
iv. **CLO 4:** Check research accuracy and present research findings

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	1	3	3	2	1	1	1	1	2	2
CLO 2	1	3	3	2	1	1	1	2	2	3
CLO 3	1	2	3	2	1	1	1	2	3	2
CLO 4	1	3	3	2	1	1	1	2	2	3

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Introduction to research methodology, objectives, types of research, methodology vs. methods, research process, qualities of a good research, problems and prospects of marine research in Bangladesh	Week-1	Lecture, Discussion	Assignment	CLO 1
2	Selecting and defining a research problem, techniques of defining a problem	Week-2	Lecture, Discussion	Class performance and interactions	CLO 1
3	Design of research plan, concept of research design, needs for research design, types of research design	Week-3	Lecture, Group Discussion	Class Test/Quiz-1	CLO 2
4	Sampling strategies, developing methodology for sampling design, sampling techniques for water parameters, sediments, bacteria, plankton, benthos and nekton.	Week-4	Interactive discussion, white board illustration	Presentation, interactions	CLO 3
5	Data collection (Primary Method): Collection of data through questionnaires. Collection of data through Schedule, Difference between Questionnaires and Schedules, constructing questionnaire and schedule	Week-5	Power point presentation, white board illustration	Assignment	CLO 3
6	Data collection (Secondary Method): Various Methods of Secondary data collection.	Week-6	Power point presentation, discussion on assignments	Oral viva, interactions	CLO 3
7	**Mid-Term Examination** AI applications in scientific research workflows.	Week-7	- Power point presentation, white board illustration	-	-
8	Case study Method	Week-8	Power point presentation, discussions on	Sketching the diagrams	CLO 3

			mid-term scripts		
9	Accuracy of results (a. Types of errors and their control, b. Replication and standard samples)	Week-9	Lecture, Discussion	Class Test/Quiz-2	CLO 4
10	Accuracy of results (c. Degrees of accuracy, calculations and level of significance)	Week-10	Lecture, independent reading	Group assignment	CLO 4
11	Presentation of research findings (a. Data processing, data analysis, graphical representation, Statistical & Ecological analyses and tabulation.)	Week-11	Power point presentation, interactive Q&A	Brain-storming and performance	CLO 4
12	Presentation of research findings (b. Manuscript preparation (thesis/dissertation))	Week-12	Power point presentation, independent reading	Class Test/Quiz-3	CLO 4
13	Presentation of research findings (c. Writing techniques of research proposal for funding d. Monitoring and evaluation of research projects e. Research report preparation)	Week-13	Power point presentation, independent reading	Assignment	CLO 4
14	Research extension processes (seminar, symposium, workshop, training programme, popular and scientific paper publication).	Week-14	Power point presentation	Group Presentation	CLO 4

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1				10
Understand		1	3		3	10
Apply	**5**	1	3		5	10
Analyze		1	2	3	5	15
Evaluate		1	2	2	2	10
Create						5

PART D

14) Reference Books:

- Research Methods in Marine Biology, by C. Schlieper, University of Washington Press (1972), ISBN: 0295952342.
- How to write scientific papers, Elsevier.
- Research Methodology: Methods and Techniques, by C. R. Kothari, New Age International, ISBN: 8122415229.
- A guide to Research Proposal and Report Writing, by A. R. Moten, Research centre, IIUM, 1998, ISBN: 9839727087.

Course Title: Marine Biodiversity and Conservation	
Course Code: OCN 3209	**Credit: 2.0**

PART A

1) Course Code: OCN 3209

2) Course Title: Marine Biodiversity & Conservation

3) Course Type: FC

4) Year and Semester: Year 3, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 2

7) Contact Hours: 28

8) Total Marks: 100

9) Course Summary and Objectives:

Marine environment is rich in biodiversity. The course has been designed to understand this biodiversity which have great ecological value.
Course objectives include –

- To learn about the value of biodiversity.
- To know the biodiversity measurement processes.
- To understand the treats and conservation techniques.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Understand the concept of biodiversity.
ii. **CLO 2:** Measure biodiversity.
iii. **CLO 3:** Importance, threats and conservation of marine biodiversity.

13) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	1	1	1	1	3	3	2	2	2	1
CLO 2	1	1	1	1	3	3	3	2	2	1
CLO 3	1	1	1	1	3	3	3	2	2	1

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

11) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Introduction Definition and concepts	Week-1	Lecture, Discussion	Assignment	CLO 1
2	Genetic, species and ecosystem biodiversity	Week-2	Lecture, Discussion, Video Presentation	Class performance and interactions	CLO 1, CLO 3
3	Measuring Biodiversity Number and differences Surrogacy	Week-3	Lecture, Group Discussion	Class Test/Quiz-1	CLO 1, CLO 2
4	Measuring Biodiversity Richness Evenness	Week-4	Interactive discussion, white board illustration	Presentation, interactions	CLO 1, CLO 2
5	The Value of Biodiversity Ecological value Ethical value	Week-5	Power point presentation, white board illustration	Assignment	CLO 2, CLO 3
6	Threats to Biodiversity Extinctions Extinctions of the Past Human-caused extinctions: Extinction rates, Vulnerability of extinctions,	Week-6	Power point presentation, white board illustration, discussion on assignments	Oral viva, interactions	CLO 2, CLO 3
7	**Mid-Term Examination** Causes of extinctions: exploitation, habitat destruction, degradation and pollution, biological invasions.	Week-7	- Power point presentation, white board illustration, discussion on assignments	- Oral viva, interactions	- CLO 2, CLO 3
8	Coastal and marine waters biodiversity of Bangladesh -St. Martin's Island biodiversity	Week-8	Power point presentation, white board illustration, discussions on mid-term scripts	Sketching the diagrams	CLO 2, CLO 3
9	Mangrove (Sundarbans) Biodiversity Estuarine Biodiversity	Week-9	Lecture, Discussion	Class Test/Quiz-2	CLO 2
10	Definition and Concepts Importance of Conservation	Week-10	Lecture, independent reading	Group assignment	CLO 1, CLO 3

11	The Rise of Modern Conservation Approaches of Conservation	Week-11	Power point presentation, white board illustration, interactive Q&A	Brain-storming and performance	CLO 3
12	Biodiversity conservation inside Protected Areas Establishing Protected Areas Designing Protected Areas Measuring Protected Areas: Protected Areas and people	Week-12	Power point presentation, white board illustration	Class Test/Quiz-3	CLO 1, CLO 2
13	Biodiversity conservation outside Protected Areas International Agreements on Biodiversity Conservation	Week-13	Power point presentation, white board illustration, independent reading	Assignment	CLO 1, CLO 3
14	MPA: SoNG MPA, Nijhum Dwip MPA	Week-14	Power point presentation, white board illustration	Group Presentation	CLO 3

PART C

15) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	2		2	10
Understand		1	2	1	3	10
Apply	5	1	2	1	2	15
Analyze		1	2	1	3	15
Evaluate		1		1	2	5
Create			2	1	3	5

PART D

16) Textbook:

- Biodiversity: An introduction, by K.J. Gaston and J.I. Spicer,Blackwell Science (1998), ISBN: 1-4051-1857-1.
- Species diversity in space and time, by M.L. Rosenzweig, Cambridge University Press (1995), ISBN: 0883853396.

17) Reference Books:

- Species diversity in ecological communities: Historical and geographical perspectives, by R.E.Ricklefs and D. Schulter, *University* Of Chicago *Press*(1st edition, 1994), ISBN: 9780226718231.
- Biodiversity, by E.O. Wilson and F.M. Peter, National Academic Press (1998), ISBN: 0-309-03783-2.

Course Title: Viva-voce	
Course Code: OCN 3210	**Credit: 1.5**

PART-A

1) **Course Code:** OCN 3210

2) **Course Title:** Viva-Voce

3) **Course Type:** FC

4) **Year and Semester:** Year 3, Semester 2

5) **Prerequisite (if any):** N/A

6) **Credit Value:** 1.5

7) **Contact Hours:** N/A

8) **Total Marks:** 100

Viva voce will be conducted towards the end of the academic year which will be covering the complete syllabus. This will assess the student's knowledge and understanding during the course of their graduate programme. In doing so, the main objective of this course is to prepare the students to face interview both at the academic and the professional arenas.

9) **Course Objectives:**

The primary aim of the course is to develop students' confidence in oral assessments and to evaluate the conceptual understanding gained during their first year of undergraduate education.

10) **Course Learning Outcomes (CLOs):**

Upon successful completion of the course the students will be able to:

iii. CLO1: To describe and explain their understanding of the theoretical and practical fundamental courses.

iv. CLO2: Get prepared to face the interview both at the academic and the professional arenas.

11) **Mapping of CLOs with Program Learning Outcomes (PLOs):**

PLO / **CLO**	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	2	**3**	**3**	2	2	2	**3**	2	2
CLO 2	2	2	2	2	2	2	2	**3**	2	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

14) **Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques**

Course Contents	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1. Comprehensive assessment of all courses offered in the third year, spanning both the first and second semesters.	Viva	Oral Exam	CLO 1, CLO 2

Course Title: Field Work III: Oceanographic Cruise Techniques	
Course Code: OCN 3211	**Credit: 2.0**

PART A

1) Course Code: OCN 3211

2) Course Title: Field Work III: Data Acquisition by Ship

3) Course Type: SKD

4) Year and Semester: Year 3, Semester 2

5) Prerequisite (if any): Introduction to Hydrography

6) Credit Value: 1.5

7) Contact Hours: N/A

8) Total Marks: 100

9) Course Summary and Objectives:

This course offers practical exposure to hydrographic surveying using standards from the International Hydrographic Organization (IHO). It includes pre-field planning, field data acquisition, post-processing, and final charting. Students will learn to operate hydrographic equipment, manage data workflows, and create accurate bathymetric products. Course objectives include –

- To understand and apply hydrographic survey methods in a field setting.
- To operate and calibrate survey instruments such as echo sounders, GNSS receivers, and motion sensors.
- To process hydrographic data for bathymetric modeling and chart production.
- To evaluate survey quality and prepare standard-compliant reports and charts.

10) Course Learning Outcomes (CLO):

i) **CLO 1:** Plan and prepare for a hydrographic field survey, including equipment setup and safety.

ii) **CLO 2:** Conduct field data acquisition using standard hydrographic equipment and procedures.

iii) **CLO 3:** Process, clean, and model hydrographic data to produce bathymetric charts.

iv) **CLO 4:** Compile and present a comprehensive survey report and final data products.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	3	3	2	3	1	1	1	2	2	2
CLO 2	3	3	3	3	1	1	1	2	2	2
CLO 3	3	3	3	3	1	1	1	2	3	3
CLO 4	3	3	3	3	1	1	1	2	3	3

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Field Trip Activities and Modules	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	**Integrated Field Module**: Pre-field planning, equipment setup (GNSS, tide gauges, echo sounders), safety briefing; field survey operations including sounding (SBES/MBES), GNSS positioning, sonar imaging, object detection, and environmental data collection (SVP, motion sensors)	Day 1-2	Hands-on field practice, equipment demo, instructor walkthrough	Logbook check, observation sheets, data collection quality	CLO 1, CLO 2
2	**Post-Processing and Reporting Module**: Data import, corrections (tide, SVP), generation of DBMs/charts, QC, final report compilation and presentation	Day 2-4	Software lab sessions, instructor-guided reporting workshop	Final report (20 marks), Chart task, Viva (15 marks)	CLO 3, CLO 4

PART C

Bloom's Category	Semester Final Examination			
	Attendance (10)	**Field Performance (30)**	**Report (40)**	**Presentation / Viva (20)**
Remember		5	5	5
Understand		5	5	5
Apply	10	5	5	5
Analyze		5	5	5
Evaluate		5	5	
Create		5	5	

PART D

Textbooks and Manuals:

1. *Manual on Hydrography*, International Hydrographic Organization (IHO), Publication C-13.
2. *Principles of Hydrographic Surveying*, by John E. Hughes Clarke.
3. *Elements of Physical Oceanography for Hydrographic Surveyors*, IHO/FIG/ICA Certified Courses.

Software & Tools:

- Hydrographic processing software: Qinsy, Hypack, CARIS HIPS and SIPS
- GNSS post-processing: Trimble Business Center, RTKLib
- Charting & GIS: QGIS, ArcGIS, AutoCAD Civil 3D
- Programming/scripting: Python (for SVP, CSV cleaning, etc.)

Instruments and Equipment (Lab/Field Use):

- GNSS Receivers (RTK-capable)
- Single-beam and Multibeam Echo Sounders
- Side Scan Sonar
- Tide Gauge
- SVP Profiler
- Motion sensors (IMU/INS)
- Workboat/Vessel with mountable equipment frame

Other Learning Materials:

- IHO S-44: Standards for Hydrographic Surveys
- IHO S-57/S-100: Electronic Charting Specifications
- Field logs, calibration sheets, equipment manuals, and survey datasheets

Detail Syllabus Seventh Semester (Year-4, Semester-1)

Course Title: Ocean Modeling	
Course Code: OCN 4101	**Credit: 2.0**

PART A

1) Course Code: OCN 4101

2) Course Title: Ocean Modeling

3) Course Type: CC

4) Year and Semester: Year 4, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 2

7) Contact Hours: 28

8) Total Marks: 100

9) Course Summary and Objectives:

This course introduces students to the concepts and methodologies used in ocean modelling. Topics include numerical modelling of oceanic processes, model validation, and the application of models in oceanographic research. Students will learn how to set up and run basic ocean models, analyze model output, and understand the significance of various oceanic processes such as circulation, waves, and thermohaline dynamics. The course aims to equip students with the skills to apply modelling techniques to address real-world oceanographic problems and enhance their understanding of ocean systems.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Understand the basic principles of ocean modelling, including the types of models used in oceanography.
ii. **CLO 2:** Learn the numerical methods and algorithms used in ocean models to simulate oceanic processes such as circulation, waves, and thermohaline dynamics.
iii. **CLO 3:** Develop and implement simple ocean models using appropriate software tools.
iv. **CLO 4**: Analyze and interpret the output of ocean models, including validation and sensitivity analysis.
v. **CLO 5**: Apply ocean models to real-world oceanographic problems, particularly in the context of coastal and global ocean circulation.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	3	3	3	2	3	1	1	2	3	3
CLO 2	3	2	3	2	2	1	1	2	2	2
CLO 3	2	3	2	3	2	1	1	2	3	2
CLO 4	3	2	3	2	2	1	1	2	2	2
CLO 5	3	3	2	2	3	1	2	3	3	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	**Introduction to Ocean Modelling:** Overview of ocean modelling principles and the types of models (1D, 2D, and 3D). Importance of ocean models in understanding physical oceanography and climate systems.	Week-1-2	Lecture, Discussion	Assignment on the importance and applications of ocean modelling	CLO 1
2	**Numerical Methods in Ocean Modelling:** Overview of numerical techniques such as finite difference methods, finite element methods. How these methods are applied to simulate ocean processes.	Week-3-4	Lecture, Group Discussion	Quiz on numerical methods and their applications in ocean models	CLO 2
3	**Ocean Circulation Models:** Introduction to models for ocean circulation, including the role of wind, thermohaline processes, and the Coriolis force. Setting up and running basic ocean circulation models.	Week-5-6	Hands-on Coding, Problem Solving	Lab report on ocean circulation model setup and analysis	CLO 3
4	**Mid-Term Examination** **Waves and Tides Modelling:** Introduction to wave dynamics and tidal models. Numerical	 Week-7-8	- Lecture, Case Study	- Class test on wave and tide modelling	- CLO 2, CLO 4

	approaches for simulating ocean waves and tides.				
5	**Thermohaline and Heat Transport Models:** Modelling of heat transport and thermohaline circulation in the ocean. Key parameters influencing ocean temperature and salinity.	Week-9-10	Lecture, Hands-on Coding	Lab report on heat transport and thermohaline model analysis	CLO 3, CLO 4
6	**Model Validation and Sensitivity Analysis:** Techniques for validating ocean models with observational data. Sensitivity analysis to test model robustness and identify influential parameters.	Week-11-12	Lecture, Case Study	Assignment on model validation and sensitivity analysis	CLO 4
7	**Application of Ocean Models to Real-World Problems:** Case studies of ocean models applied to real-world problems, such as climate change, coastal erosion, and marine pollution.	Week-13-14	Group Project, Discussion	Group project on applying ocean models to a specific problem	CLO 5

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	2		2	10
Understand		1	2	1	3	10
Apply	5	1	2	1	2	15
Analyze		1	2	1	3	15
Evaluate		1		1	2	5
Create			2	1	3	5

PART D

Reference Books:

- Griffies, S. M. (2004). *The Dynamics of Ocean Circulation*. Princeton University Press.
- Winton, M. (2008). *Introduction to Physical Oceanography*. University of California Press.
- Dijkstra, H. A., & Neelin, J. D. (2013). *Ocean Modeling*. Springer.

Course Title: Ocean Modeling Lab	
Course Code: OCN 4102	**Credit: 1.5 credit**

PART A

1) Course Code: OCN 4102

2) Course Title: Ocean Modeling Lab

3) Course Type: SKD

4) Year and Semester: Year 4, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 1.5

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This lab-based course gives students practical experience in modern ocean modeling. Delft3D will be used for most hands-on sessions, giving operational proficiency in model setup, running, and output analysis. Brief overviews and/or demos introduce HYCOM, ROMS, SCHISM, and SWAN—providing awareness of additional tools vital in academic and professional oceanography.

10) Course Learning Outcomes (CLO):

- **CLO 1:** Gain hands-on skills in installing, configuring, and running ocean modeling software (primarily Delft3D; overview: HYCOM, ROMS, SCHISM, SWAN).
- **CLO 2:** Effectively set up and execute 1D, 2D, and 3D simulations using real and synthetic datasets.
- **CLO 3:** Conduct model validation and basic sensitivity analysis with observational data.
- **CLO 4:** Analyze and visualize model outputs using standard ocean modeling toolkits.
- **CLO 5:** Work collaboratively in applying ocean models to real-world scenarios and communicate technical results effectively.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	**3**	**3**	2	**3**	1	1	2	**3**	2
CLO 2	**3**	2	**3**	2	2	1	**3**	1	**3**	2
CLO 3	2	**3**	2	**3**	2	1	**3**	1	2	2
CLO 4	**3**	**3**	**3**	2	2	**3**	2	1	**3**	2
CLO 5	**3**	**3**	2	**3**	2	2	**3**	**3**	2	**3**

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Allocation	Teaching Strategies	Assessment Strategies	Alignment with CLO
1	Introduction to Lab Ocean Modelling: Purpose, key model names, access to tools	Week 1-2	Demo, discussion	Short assignment on model types	CLO 1
2	Delft3D: Installation, workspace setup, files, basic preprocessing	Week 3-4	Guided practice	Lab report on workspace setup	CLO 1
3	Delft3D: Grid and boundary creation, initial condition setup	Week 4-5	Hands-on lab	Lab on domain/grid setup	CLO 2
4	Delft3D: Simple 2D/3D model runs	Week 5-6	Practice, troubleshooting	Execution review and lab log	CLO 2
5	Delft3D: Forcing, parameters, and input data	Week 7-8	Demo, case study	Quiz/lab on model configuration	CLO 2, CLO 4
6	Model validation & sensitivity: Using observation data, analyzing simulation robustness	Week 9	Data analysis workshop	Report on model validation & sensitivity	CLO 3, CLO 4
7	Delft3D-WAVE & SWAN: Introduction, running wave simulations, coupled scenarios	Week 10	Guided lab, Q&A	Short assignment on wave module	CLO 4
8	HYCOM, ROMS, SCHISM: Overview, comparison, platform demos (as time allows)	Week 11	Lecture, demo, discussion	Quiz on differences and professional relevance	CLO 1

Sl. No.	Course Contents	Time Allocation	Teaching Strategies	Assessment Strategies	Alignment with CLO
9	Visualization & technical reporting: Plots with Delft3D/standard tools, best practices	Week-13	Workshop, presentation	Report visualizing results	CLO 4
10	Mini-Project: Group setup/run/analysis of a real-world scenario (using Delft3D as core)	Week-14	Project-based, group work	Project report and presentation	CLO 5

PART C

13) Assessment and Evaluation

Bloom's Category	Semester Final Examination				
	Attend. (10)	Class Performance (10)	Assign. / Report (20)	Present. / Viva (20)	Final (40)
Remember		2		4	5
Understand		2	4	6	5
Apply	10	2	4	2	10
Analyze		2	4	3	10
Evaluate		2	4	2	5
Create			4	3	5

PART D

Reference Books:

1. Griffies, S. M. (2004). The Dynamics of Ocean Circulation. Princeton University Press.
2. Dijkstra, H. A., & Neelin, J. D. (2013). Ocean Modeling. Springer.
3. Deltares. Delft3D-FLOW User Manual (latest version).
4. Moore, A.M., et al. HYCOM Reference Manual.
5. Zhang, Y. J. et al. The SCHISM User Manual.

Course Title: Paleontology & Paleoceanography	
Course Code: OCN 4103	**Credit: 3.0**

PART A

1) **Course Code:** OCN 4103
2) **Course Title:** Paleontology & Paleoceanography
3) **Course Type:** CC
4) **Year and Semester:** Year 4, Semester 1
5) **Prerequisite (if any):**
6) **Credit:** 3
7) **Contact Hours:** 42 hours
8) **Total Marks:** 100
9) **Course Summary and Objectives**

This course explores fossil evidence to interpret the evolution and ecological roles of ancient marine organisms, ranging from invertebrates and microfossils to vertebrates including fish, reptiles, and mammals. It also introduces principles of fossil preservation, stratigraphy, biostratigraphy, paleoecology, and paleoceanographic proxy interpretation.

Course Objectives

- To explain the processes of fossilization in marine environments.
- To identify major groups of marine invertebrate and vertebrate fossils.
- To apply biostratigraphic principles and interpret geologic time using fossil data.
- To examine paleobiological and evolutionary trends in marine life.
- To analyze major marine extinction events and their fossil evidence.
- To interpret past ocean conditions using paleoceanographic proxies.

10) Course Learning Outcomes (CLOs)

i. **CLO1:** Describe the processes and conditions leading to fossilization in marine environments.
ii. **CLO2:** Identify and classify major marine invertebrate and vertebrate fossils.
iii. **CLO3:** Apply stratigraphic and biostratigraphic concepts to fossil data for reconstruction of past environment and climate.
iv. **CLO4:** Analyze evolutionary and paleoecological patterns from fossil records.
v. **CLO5:** Explain marine mass extinction events using fossil evidence.
vi. **CLO6:** Interpret paleoceanographic conditions using geochemical and biological proxies.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO1	3	3	2	2	2	1	1	1	2	2
CLO2	3	3	3	2	2	1	1	1	2	2
CLO3	2	2	3	3	2	2	1	1	3	2
CLO4	2	2	2	3	3	3	2	3	3	2
CLO5	2	2	2	3	3	2	2	1	2	2
CLO6	2	2	2	2	3	2	1	3	3	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Week	Topics	CLOs	Teaching Strategy	Assessment
1	Introduction: scope, relevance, marine fossil record, geologic time, preservation	CLO1	Lecture, timeline activity	Quiz
2	Fossilization and Marine Sedimentary Contexts: taphonomy, diagenesis	CLO1	Case study, sediment/fossil matching	Assignment
3	Major Marine Invertebrates: mollusks, corals, brachiopods, echinoderms	CLO2	Image analysis, fossil samples	Class test
4	Trilobites & Arthropods: morphology, extinction, biostratigraphy	CLO2	Diagramming, fossil records	Quiz
5	Micropaleontology: foraminifera, diatoms, coccolithophores, ostracoda, radiolaria, sediment cores	CLO2, CLO3	Microscopy visuals, core scan interpretation	Assignment
6	Application of Fossil: Biostratigraphy & Chronostratigraphy:	CLO3	Practical dating exercises	Quiz
7	**Mid-Term Examination** Biozones, index fossils, paleoenvironmental analysis.	— CLO3	— Diagramming, fossil records	Mid-Term Exam (20%)
8	Paleoecology & Evolutionary Trends: functional morphology, radiations	CLO4	Fossil function exercise, discussions	Class test
9	Fossil Marine Reptiles & Mammals: ichthyosaurs, whales, sirenians, transitions	CLO4	Adaptive evolution mapping	Short answer worksheet

	Fossil Fish and Marine Vertebrates: ecology, evolution, chemistry		Paleo food web, trophic role diagrams	
10	Paleoceanography: Use of microfossils and isotopes ($\delta^{18}O$, $\delta^{13}C$) in reconstructing ocean temperature, salinity, productivity; Sediment cores and stratigraphic archives; Linking paleoceanographic signals to glacial–interglacial cycles; Marine evidence of abrupt climate events (e.g., Younger Dryas)	CLO2, CLO5		Assignment
11	Mass Extinctions: fossil evidence, Permian/Cretaceous, biotic recovery	CLO5	Timeline reconstruction, data reading	Quiz
12	Palynology: definition, scope, and applications, Types of palynomorphs, Palynological indicators of marine–terrestrial interactions and past climates.	CLO6		Assignment
13	Marine Paleoenvironmental analysis Case Studies: integrated fossil records in marine reconstructions	CLO1–6	Proxy analysis examples, graphs	Quiz or Review Task
14	Final Assignment Submission + Viva Voce + Review	CLO1–6	Presentation, Q&A, oral assessment	Viva + Final Assignment

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	2		2	10
Understand		1	2	1	3	10
Apply	5	1	2	1	2	15
Analyze		1	2	1	3	15
Evaluate		1		1	2	5
Create			2	1	3	5

PART D

Suggested Readings

- Prothero, D.R. (2013). *Bringing Fossils to Life: An Introduction to Paleobiology*. Columbia University Press.
- Benton, M.J., & Harper, D.A.T. (2020). *Introduction to Paleobiology and the Fossil Record*. Wiley-Blackwell.
- Brenchley, P. & Harper, D. (1998). *Paleontology: Environment and Evolution*. Springer.
- Haywood, A. et al. *Paleoceanography and Paleoclimatology* – AGU Publications.
- Armstrong, H., & Brasier, M. (2005). Microfossils (2nd ed.). Wiley-Blackwell. ISBN: 978-0-632-05279-0
- Cushman, J. A. (1948). Foraminifera: Their classification and economic use (4th revised and enlarged ed.). Harvard University Press.
- Relevant open-access papers and IODP/ODP core reports for proxy examples.

Course Title: Coastal and Marine Pollution	
Course Code: OCN 4105	**Credit: 3.0**

PART A

1) Course Code: OCN 4105

2) Course Title: Coastal and Marine Pollution

3) Course Type: CC

4) Year and Semester: Year 4, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

Pollution causes a negative/undesirable change in the marine and coastal environment by adding something hazardous or detrimental. That's why a multidisciplinary overview of contemporary pollution issues is required for the proper appraisal of pollution in coastal and marine environment. Course objectives include –

- To know about the characteristics of pollutants, various sources and effects of pollutants on the marine environment.
- To learn about various impacts of pollution.
- To learn about the techniques of reducing pollution levels.

10) Course Learning Outcomes (CLO):

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

i. **CLO 01:** Acquire knowledge on various topics relevant to the pollution of the marine and coastal environment.
ii. **CLO 02:** Understand the sources of pollution, effects and techniques to deal with pollution.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / **CLO**	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	2	2	2	2	2	2	3	3	3	2
CLO 2	2	2	2	2	2	2	3	3	3	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	**Introduction** (Definition of pollution, types, contamination and sources of air pollution, water pollution, coastal and deep-sea pollution, effect of pollutants on organism)	Week-1	Lecture, Discussion	Participation	CLO 1, CLO 2
2	**Air Pollution** (Definition, major sources of air pollution, effect of air pollution on human beings. Greenhouse gases: sources, effect on global warming and sea-level changes.)	Week-2	Lecture, Discussion, Video Presentation	Class performance and interactions	CLO 1, CLO 2
3	**Air Pollution** (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.)	Week-3	Lecture, Group Discussion	Class Test/Quiz-1	CLO 1, CLO 2
4	**Air Pollution** (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.)	Week-4	Interactive discussion, white board illustration	Presentation, interactions	CLO 1, CLO 2
5	**Water Pollution:** (Types, sources and consequences of water pollution. Ecological and biological aspects of water pollution. Types and characteristics of domestic, industrial and agricultural	Week-5	Power point presentation, white board illustration	Assignment	CLO 1, CLO 2

	waste and their effects on water bodies.)				
6	**Sewage:** (Definition of sewage, sources and types of sewage, Characteristics of sewage, Sewage treatment,	Week-6	Power point presentation, white board illustration, discussion on assignments	Oral viva, interactions	CLO 1, CLO 2
7	**Mid-Term Examination** Eutrophication and its effect. Solid waste disposal problem and its management in urban area.)	Week-7	- Power point presentation, white board illustration, discussion on assignments	- Oral viva, interactions	- CLO 1, CLO 2
8	**Sewage:** Industrial Wastes	Week-8	Power point presentation, white board illustration, discussions on mid-term scripts	Sketching the diagrams	CLO 1, CLO 2
9	**Sewage:** (Sources of effluents, nature of effluents of some industries, Effects of effluents on aquatic ecosystem, Waste treatment: Primary treatment, Secondary treatment and Tertiary treatment.)	Week-9	Lecture, Discussion	Class Test/Quiz-2	CLO 1, CLO 2
10	**Heavy Metals:** (Introduction, Sources of heavy metals, Effects of heavy metals on aquatic ecosystem. Bioaccumulation and bio-magnification of lead, cadmium, chromium & mercury)	Week-10	Lecture, independent reading	Group assignment	CLO 1, CLO 2
11	**Agro-Chemicals:** (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.)	Week-11	Power point presentation, white board illustration, interactive Q&A	Brain-storming and performance	CLO 1, CLO 2

12	**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.)	Week-12	Power point presentation, white board illustration	Class Test/Quiz-3	CLO 1, CLO 2
13	**Plastic pollution:** (Types of plastic pollution, Sources of plastic pollution, Impact of plastic pollution on marine food web, Plastic pollution in Bangladesh coastal and marine waters)	Week-13	Power point presentation, white board illustration, independent reading	Assignment	CLO 1, CLO 2
14	**Toxicology:** (Introduction, principles and concepts, classification and sources of toxic substances. Pathways of toxic substances into ecosystem. Effect of toxic substances – emphasis on physiological effects.)	Week-14	Power point presentation, white board illustration	CT/Quiz-04	CLO 1, CLO 2

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5			10
Understand		1	5		5	10
Apply	5	1			5	10
Analyze		1		2	5	10
Evaluate		1		2		10
Create				1		10

PART D

Recommended Texts:

9. Global Air Pollution, by H Bridgman, John Wiley & Sons (1990), ISBN: 0471944955.
10. Principles of Air Pollution Methodology, by T Lyons and B Scott.CBS Pub. & Distributor (1992).
11. Atmospheric Chemistry & Physics, by J.H. Seinfeld, John Wiley & Sons (1998), ISBN: 978-1-118-94740-1.

12. Environmental Water Pollution and Control,by **G**.R.Chhatwal, M.C. Mehra, Mohan Katyal, T. Katyal, T. Nagahiro**,** Anmol Publication, New Delhi, ISBN: 8170412145.
13. Water Pollution, by A. K.Tripallhi, Astish Publication, New Delhi (1990).
14. Assessment of Water Pollution, by S. R. Mishra, APH Publication, New Delhi (1996).
15. River Pollution–an Ecology Perspective, by S. M.Haslam, CBS Publication& Distributor, New Delhi (1990).
16. Standard Methods for the Examination of Water & Wastewater, by APHA (American Public Health Association). Washington. D.C. (1996), ISBN: 0875532292.

Course Title: Marine Biogeochemistry	
Course Code: OCN 4107	**Credit: 3.0**

PART A

1) Course Code: OCN 4107

2) Course Title: Marine Biogeochemistry

3) Course Type: FC

4) Year and Semester: Year 4, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

To understand the relationship among chemical, biological and geological processes in seawater.

- Deep understanding of the distribution of the chemical components of the ocean, the cycling of key components, which chemical/biological/geological processes influencing the cycling, and how the cycles are coupled to climate and climate changes
- An overview of how different processes influence the chemistry of the ocean, including the role of vertical mixing, advection, biological processes and gas exchange between the air-sea interface

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Knowledge about the known marine biogeochemical processes and scientific challenges at the interfaces of seawater, landmasses, sediment and atmosphere

ii. **CLO 2:** Understand primary production in the ocean

iii. **CLO 3:** Describe the distribution of carbon and nutrients in the ocean and the processes that generate these distributions.

iv. **CLO 4:** Explain different chemical cycles in the ocean; e.g. carbon, oxygen, nutrients, silica, and trace elements such as iron

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	1	1	2	2	3	2	3	3	3	1
CLO 2	1	1	1	2	3	1	3	2	3	1
CLO 3	1	3	2	3	3	1	3	3	3	2
CLO 4	1	3	2	2	3	1	3	2	3	2

**(Weightage: 3-High, 2-Medium, 1-Low)*

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	A historical sketch of biogeochemical cycles	Week-1	Lecture, Discussion	Assignment	CLO 1
2	Cycles of major elements in the deep ocean: Introduction	Week-2	Lecture, Discussion, Video Presentation	Class performance and interactions	CLO 1, CLO 3
3	Mass balance between river input and oceanic sediment outputs for minor and trace elements	Week-3	Lecture, Group Discussion	Class performance and interactions	CLO 1, CLO 2
4	Biogeochemical cycles Description: Water cycle, carbon cycle Oxygen cycle.	Week-4 To Week-6	Interactive discussion, white board illustration	Class performance, interactions and Class Test/Quiz-1	CLO 1 CLO 2 CLO 3 CLO 4
5	**Mid-Term Examination** Nitrogen cycle, Phosphorus cycle, The sulfur cycle	Week-7	- Interactive discussion, white board illustration	- Class performance, interactions and	CLO 1 CLO 2 CLO 3 CLO 4
6	Air-sea carbon dioxide fluxes.	Week-8	Power point presentation, white board illustration, discussions on mid-term scripts	Sketching the diagrams	CLO 2, CLO 4
7	Primary production in the ocean: nutrient supply, primary producers, seasonal cycles, spring bloom, nitrogen fixation. Redfield ratio Nutrient cycling	Week-9 Week-10	Lecture, Discussion	Class Test/Quiz-2	CLO 2
8	Si, P and Fe biogeochemical cycles.	Week-11	Lecture, independent reading	Assignment	CLO 1, CLO 3

9	Sediments, sediment-water interface, their role on the oceanic cycle	Week-12	Power point presentation, white board illustration	Brain-storming and performance	CLO 1 CLO 3
10	Ocean acidification and carbonate chemistry; Long term evolution of the biogeochemical cycles of the Earth.	Week-13	Power point presentation, white board illustration, independent reading	Brain-storming and performance	CLO 1, CLO 3
11	Benthic processes of biogeochemical cycles.	Week-14	Power point presentation, white board illustration	Class performance	CLO 3
12	Student Presentation	Week-15	Power point presentation	Presentation Assessment	CLO 1 CLO 2 CLO 3 CLO 4
13	Student Presentation	Week-16	Power point presentation		

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5			10
Understand		1	5		5	10
Apply		1			5	10
Analyze		1		2	5	15
Evaluate		1		2		10
Create				1		5

PART D

14) Textbooks:

- An Introduction to Marine Biogeochemistry, M. Susan, Elsevier, ISBN: 978-0-120885305.
- Chemical Cycles in the Evolution of the Earth, C. B. Gregor, R.M. Garrels, F.T. Mackenzie and J. B. Maynard, Wiley, New York.
- Ocean Biogeochemical Dynamics, Jorge L. Sarmiento and Nicholas Gruber, 2006, Princeton University Press.

Course Title: Energy and Mineral Resources	
Course Code: OCN 4109	**Credit: 3.0 credit**

PART A

1) Course Code: OCN 4109

2) Course Title: Energy and Mineral Resources

3) Course Type: FC

4) Year and Semester: Year 4, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course provides foundational and applied knowledge of mineral and energy resources, covering types, formation processes, exploration techniques, and the relevance to national and regional contexts like Bangladesh and the Bay of Bengal. Emphasis is given to both renewable and non-renewable energy sources, as well as subsurface conditions like overpressure.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Explain the classification, formation processes, and occurrences of key mineral deposits.
ii. **CLO 2:** Describe and analyze non-renewable and renewable energy resources, including their origin, distribution, and uses.
iii. **CLO 3:** Evaluate the potential and challenges of mineral and energy resources in Bangladesh and the Bay of Bengal.
iv. **CLO 4:** Interpret subsurface geological data related to temperature, pressure, and overpressure conditions.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / **CLO**	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	1	3	3	2	1	2	3	2	1	2
CLO 2	3	2	3	2	3	1	2	1	1	2
CLO 3	1	3	2	3	2	3	3	2	1	2
CLO 4	1	3	2	3	1	3	2	1	2	3

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Introduction to Energy and Mineral Resources • Classification of natural resources: Renewable vs Non-renewable • Role of geosciences in resource exploration and management • Classification and Global Distribution of Resources • Global and regional perspectives on resource distribution • Importance of energy and mineral resources • Sustainability challenges and future outlook	Week-1	Lecture, Discussion	Assignment	CLO 1 CLO 2
2	**Mineral Resources:** -Mineral formation 2.1 **Hydrothermal Deposits** • Formation mechanisms of hydrothermal mineral deposits • Ore-forming fluids and host rock interactions • Types: Vein-type, Porphyry, Epithermal, and Skarn deposits • Examples of hydrothermal systems globally and locally 2.2 **Deep-Sea Mineral Deposits** • Geological settings: mid-ocean ridges, seamounts, and abyssal plains • Exploration techniques for deep-sea minerals • Legal and environmental issues in deep-sea mining **2.3 Placer Deposits** • Formation and concentration processes in fluvial, beach, and aeolian environments	Week-2 Week-3 Week-4 Week 5	Lecture, Discussion, Video Presentation	Class performance and interactions	CLO 1, CLO 3

	• Economic minerals in placers (e.g., gold, tin, zircon, diamond) • Exploration and recovery methods **2.4 Heavy Minerals** • Identification and classification of heavy minerals • Provenance analysis and its significance • Economic potential of heavy minerals in sedimentary environments **2.5 Polymetallic Sulphides** • Formation of seafloor massive sulphide (SMS) deposits • Mineralogical composition: sulfides of Cu, Zn, Pb, Au, Ag • Tectonic settings: hydrothermal vents, black smokers **2.6 Polymetallic Manganese Nodules and Cobalt-rich Ferromanganese Crusts** • Formation processes on the abyssal seafloor • Economic metals: Mn, Ni, Cu, Co, REEs • Distribution in the Pacific and Indian Oceans • Mining potential and technological challenges				
3	Mineral Resources of Bangladesh and the Bay of Bengal • Overview of key mineral deposits in Bangladesh (e.g., limestone, silica sand, clay, heavy minerals) • Offshore mineral prospects in the Bay of Bengal • National mineral policy and resource development initiatives	Week 6	Lecture, Group Discussion	Class Test/Quiz-1	CLO 2, CLO 3 CLO 4
4	**Energy Resources** **Non-Renewable Energy Resources** **Natural Gas** • Origin and formation processes of natural gas • Conventional vs unconventional gas (shale gas, tight gas)	Week 7 Week 8	Interactive discussion, whiteboard illustration	Presentation, interactions	CLO 2, CLO 3

	• Bangladesh gas reserves: onshore and offshore basins • Geological characteristics of key gas fields (e.g., Titas, Bibiyana) • Potential and challenges of shale gas in Bangladesh **Crude Oil** • Origin and accumulation of petroleum • Source rocks, migration, traps, and reservoirs • Global oil reserves and geopolitics • Oil prospects in the Bay of Bengal				
5	**Mid-Term Examination** **Coal** • Types and ranks of coal (lignite to anthracite) • Origin: peat formation, burial, and coalification • Major coal deposits in Bangladesh (e.g., Barapukuria, Phulbari) • Environmental and social concerns of coal mining **Gas Hydrate** • Structure and occurrence of methane hydrates • Potential as a future energy resource • Challenges in exploration and extraction • Gas hydrate occurrences in the Bay of Bengal	- Week-8	- Interactive discussion, whiteboard illustration	- Presentation, interactions	- CLO 2, CLO 3
6	**Non-Renewable Energy Resources** **Crude Oil** • Origin and accumulation of petroleum • Source rocks, migration, traps, and reservoirs • Global oil reserves and geopolitics • Oil prospects in the Bay of Bengal **Coal**	Week-9 Week 10	Interactive discussion, whiteboard illustration		CLO 2, CLO 3

	• Types and ranks of coal (lignite to anthracite) • Origin: peat formation, burial, and coalification • Major coal deposits in Bangladesh (e.g., Barapukuria, Phulbari) • Environmental and social concerns of coal mining **Gas Hydrate** • Structure and occurrence of methane hydrates • Potential as a future energy resource • Challenges in exploration and extraction • Gas hydrate occurrences in the Bay of Bengal				
7	**Renewable Energy Resources** **Biomass Energy** • Types: wood, crop residues, animal waste • Biogas and biofuel production • Role in rural energy supply **Solar Energy** • Solar radiation potential in Bangladesh • Technologies: photovoltaic cells, solar thermal systems • Applications and integration in national energy mix **Wind Energy** • Wind patterns and potential sites in coastal and offshore Bangladesh • Wind turbine technology and constraints **Tidal Energy** • Tidal range and current energy • Site suitability in estuarine and coastal regions • Environmental considerations **Geothermal Energy** • Geothermal gradient and heat flow • Geothermal provinces worldwide • Low enthalpy resources and potential in Bangladesh	Week 11 Week 12	PowerPoint presentation, whiteboard illustration, discussions on mid-term scripts	Sketching the diagrams	CLO 2, CLO 3

	Hydroelectric Power • Principles of hydroelectric generation • Major hydro projects globally and in South Asia • Small-scale hydro potential in hilly regions of Bangladesh				
8	**Overpressure and Subsurface Evaluation** • Definition and causes of overpressure (e.g., undercompaction, hydrocarbon generation) • Subsurface temperature and pressure regimes • Importance in drilling and exploration safety • Techniques to evaluate and predict overpressure zones (well logging, seismic indicators) • Case examples from Bangladesh sedimentary basins	Week-13	Lecture, Discussion	Class Test/Quiz-2	CLO 4
9	Geopolitics of resource control Case Studies and Field Data Analysis	Week 14	Lecture, Discussion		CLO 3 CLO 4

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5			10
Understand		1	5		5	10
Apply	5	1			5	15
Analyze		1		3	5	15
Evaluate				2		10
Create		1				

PART D

Reference Books:

1. Jensen, M.L., & Bateman, A.M. (1981) Economic mineral deposits (3rd Edition). John Wiley & Sons Inc.

2. Pohl, W.L. (2011) Economic Geology: Principles and Practice. Wiley-Blackwell.

3. Smirnov, V.I. et al. (Eds.) (1983) Studies of mineral deposits. MIR Publishers.

4. Imam, B (2005) Energy Resources of Bangladesh - Natural Gas, Oil and Coal. University Grants Commission of Bangladesh.

5. Racey, A. & Ridd, M.F. (2015) Petroleum Geology of Myanmar. Geological Society of London.

6. Tyner, W.E. (2012) Energy resources and economic development in India. Springer Science & Business Media.

7. Banarjee, D.K. (1998) Mineral Resources of India. World Press Private Limited.

8. Sinha, R.K. and Sharma, N.L. (1970) Mineral Economics: A Text Book for University. Oxford & IBH Publishing Company.

9. Beyschlag, F.H.A., et al. (1914) The Deposits of the Useful Minerals and Rocks. Macmillan and co., limited.

Course Title: Integrated Coastal Zone Management	
Course Code: OCN 4111	**Credit: 3.0**

PART A

1) Course Code: OCN 4111

2) Course Title: Integrated coastal zone management (ICZM)

3) Course Type: CC

4) Year and Semester: Year 4, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

This course introduces the concepts, principles, and practices of Integrated Coastal Zone Management (ICZM), viewing the coastal zone as a dynamic system shaped by natural processes and human activities. It addresses coastal hazards, climate change impacts, vulnerability and resilience, and applies frameworks such as DPSIR for coastal studies. The course also examines management issues including population growth, resource exploitation, land-use change, and biodiversity conservation, while exploring administrative, social, and technical tools for sustainable management. Emphasis is placed on the ICZM planning cycle—design, implementation, monitoring, and evaluation—along with case studies, best practices, and the complementary role of Marine Spatial Planning (MSP) in balancing ecological integrity and human use.

Course objectives include –

- To explore the structure, functions, and dynamics of coastal zones, including interactions between ecological, physical, and socio-economic components.
- To examine coastal hazards, vulnerabilities, and resilience, applying models and frameworks such as DPSIR for integrated risk assessment and climate adaptation planning.
- To introduce administrative, social, and technical tools for sustainable coastal resource management, including policies, community-based approaches, and GIS/remote sensing techniques.
- To focus on designing, implementing, and evaluating ICZM and Marine Spatial Planning strategies, incorporating best practices, stakeholder participation, and case studies for effective coastal governance.

12) Course Learning Outcomes (CLO):

i. **CLO 1:** Explain the structure, functions, and dynamics of coastal zones and their ecological, physical, and socio-economic interactions.

ii. **CLO 2:** Assess coastal hazards, vulnerabilities, and resilience using integrated models and risk management frameworks.

iii. **CLO 3:** Apply administrative, social, and technical tools for sustainable coastal resource management.

iv. CLO 4: Develop and evaluate ICZM and Marine Spatial Planning strategies incorporating best practices, stakeholder participation, and case studies.

13) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	3	1	3	2	1	2	3	2	2	1
CLO 2	3	2	3	3	1	2	3	2	2	1
CLO 3	2	3	2	3	1	2	3	3	2	2
CLO 4	2	3	3	3	2	2	3	3	3	3

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

13) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	**Introduction and Concepts,** ● Definitions of ICZM ● Boundaries of the coastal zone ● View of coastal zone as a system ● Characteristics of the coastal zone ● Needs and objectives of ICZM (Component uses, Ecosystem uses, Functions) ● Multiple Uses of the Coastal Zone	Week 1&2	Lecture, Discussion	Assignment	CLO 1
2	● Coastal hazards (sea level rise, storm surge, coastal flooding, shoreline change) ● Climate Change mitigation and adaptation strategies ● coastal vulnerability and resilience, multi-risk in the coastal zone Models to study the coasts	Week 3, 4 & 5	Lecture, Discussion, Video Presentation	Class performance and interactions	CLO 1 CLO 2, CLO 3

	● DPSIR model				
3	Integrated Coastal Zone Management, principles, contents and mechanisms	Week 6	Lecture, Group Discussion	Class Test/Quiz-1	CLO 1, CLO 3
	Mid Term Examination Coastal Zone Management Issues ▪ Population growth ▪ Resource exploitation ▪ Land use change	Week 7	- Lecture, Discussion	- Class performance and interactions	- CLO 2
	Coastal Zone Management Issues ▪ Conservation reserves and protection of biodiversity ▪ Resource use conflicts ▪ Horizontal and vertical integration	Week-8	Lecture, Discussion	Class performance and interactions	CLO 2
	Ecosystem Approaches to Sustainable Coastal Resources Management	Week-9	Lecture, Discussion	Class performance and interactions	CLO 1 CLO 3
	Tools and Techniques for ICZM ● Administrative (Policy and legislation, Guidelines, Zoning) ● Social (Traditional practices, Collaborative and community-based management, Capacity building) ● Technical (Environmental Impact Assessment, Risk and hazard assessment and management, Landscape and visual resource analysis, Economic analysis, Remote Sensing and GIS) ● Horizontal and vertical integration	Week-10	Power point presentation	Presentation (Individual)	CLO 3
4	**Regional databases and Knowledge framework for coastal risks management,** ICZM Planning Cycle ● Classifying coastal management plans ● Designing a coastal planning framework ● ICZM plans described by geographical coverage	Week-11,12	Interactive discussion, white board illustration	Assignment	CLO 3, CLO 4

	(International integrated plans, regional scale integrated plans, Local area integrated plans, Site-level integrated plans) ● Planning processes (Administrative process, public participation, Producing the plan) ● The implementation of coastal management plans ● Monitoring and evaluation ● Case study				
5	Coastal risks management, Integrated approach and best practices in littoral management and protection; Solutions and best practices	Week-13	Power point presentation, white board illustration	Oral viva, interactions	CLO 3, CLO 4
6	Marine Spatial Planning: Definitions, MSP in a national setting, MSP in an EU context: relationship to MSFD (Marine Strategy Framework Directive), Planning processes, Defining and designating valuable areas for both ecosystems and human use, Estimating impacts and vulnerability, Zoning – area conflicts	Week-14,15	Power point presentation, white board illustration, discussion on assignments	Sketching the diagrams	CLO 4

PART C

14) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5			10
Understand		1	5		5	10
Apply	**5**	1			5	15
Analyze		1		2	5	10
Evaluate		1		2		10
Create				1		5

PART D

Reference Books:

1. Coastal Planning and Management, by R. Kay and J. Alder, New York: E & FNSpon (1999), ISBN 0419243402.
2. Coastal Environmental Management Plan for Bangladesh, ESCAP, 1988.
3. Integrated Management of Coastal Zone, by John R. Clark, FAO, 1992, ISBN 9251032750.
4. Integrated Coastal Management: South Asia, by B. E. Brown, DFID, 1997.

Richard A. Davis Jr, Duncan M. Fitzgerald (2004). Beaches and Coasts. Blackwell Publishing.

5. Basin Water Allocation Planning – Principles, Procedures and Approaches for basin allocation planning. Speed R. et al. (2013).
6. 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).

Detail Syllabus Eighth Semester
(Year-4, Semester-2)

Course Title: Environmental Impact Assessment	
Course Code: OCN 4201	**Credit: 2.0**

PART A

1) Course Code: OCN 4201

2) Course Title: Environmental Impact Assessment

3) Course Type: Core Course

4) Year and Semester: Year 4, Semester 2

5) Prerequisite (if any): N/A

6) Credit: 2

7) Contact Hours: 28

8) Total Marks: 100

9) Course Summary and Objectives:

This course is designed to get the knowledge about the methodology of environmental impact assessment. It is a vital tool for marine environmental management and decision making. Course objectives include –

- To know about the methodology of EIA.
- To understand the concepts, issues and various forms and stages of EIA process.
- To know about the impacts of EIA process.

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Explain the major principles of EIA
ii. **CLO 2:** Understand the different stages of EIA
iii. **CLO 3:** Know about the key aspects of EIA
iv. **CLO 4:** Access different case studies of EIA

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / **CLO**	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	1	3	3	2	1	1	3	2	2	1
CLO 2	1	2	3	3	1	1	3	2	2	2
CLO 3	1	1	2	2	1	1	2	3	3	2
CLO 4	1	1	2	2	1	1	2	3	3	3

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Introduction: History of EIA, Definition of Environmental Impact Assessment	Week-1	Lecture, Discussion	Assignment	CLO 1
2	Major issues of the EIA process	Week-2	Lecture, Discussion	Class performance and interactions	CLO 2
3	Methodological aspect of EIA (a. Preliminary activities b. Scoping methods in EIA)	Week-3	Lecture, Group Discussion	Class Test/Quiz-1	CLO 3
4	Methodological aspect of EIA (c. Baseline studies in EIA Process)	Week-4	Lecture, Interactive discussion	Presentation, interactions	CLO 3
5	EIA in Bangladesh and Bay of Bengal	Week-5	Power point presentation	Assignment	CLO 4
6	Environmental Management Plan (EMP)	Week-6	Power point presentation	Oral viva, interactions	CLO 3
7	**Mid-Term Examination** AI-based impact modeling.	Week-7	- Lecture, Interactive discussion	- Presentation, interactions	- CLO 3
8	The EIA process adopted in Asia and the pacific region	Week-8	Power point presentation	Sketching the diagrams	CLO 4
9	EIA and international/bilateral development and donor agencies	Week-9	Lecture, Discussion	Class Test/Quiz-2	CLO 4
10	EIA study in development projects	Week-10	Lecture, independent reading	Group assignment	CLO 3
11	Human Interaction with the Environment: Pollution; Waste Disposal, Geologic and Oceanographic Aspects of Environmental Health	Week-11	Power point presentation	Brain-storming and performance	CLO 1, CLO 2
12	Exploitation of Natural Resources and their Environmental Impacts Assessment	Week-12	Power point presentation	Class Test/Quiz-3	CLO 1, CLO 2
13	Landuse and Planning; Environmental Laws	Week-13	Power point presentation	Assignment	CLO 1, CLO 3
14	Environmental Conservation	Week-14	Power point presentation	Group Presentation	CLO 3

PART C

13) Assessment and Evaluation

Bloom's Category	Continuous Internal Evaluation					Semester Final Examination
	Attend. (05)	Class Performance (05)	Class Tests (10)	Assign. (05)	Mid Term (15)	Final (60)
Remember		1	5			10
Understand		1	5		5	10
Apply	5	1			5	10
Analyze		1		2	5	15
Evaluate		1		2		10
Create				1		5

PART D

14) Textbook:

a) Shrock, R.R., & Towenhofel, W.H. (1953). Principles of invertebrate paleontology. McGraw-Hill.

b) Jain, S. (2020). Fundamentals of Invertebrate Palaeontology. Springer India.

15) Reference Books:

1. Cushman, J.A. (2013) Foraminifera: Their Classification and Economic Use, 4th Revised and Enlarged Edition. Harvard University Press.

2. Markhovan, F.P. C.M.V. (1962) Post Paleozoic Ostracods (Vol 1 & 2). Elsevier.

3. Bignott, G. (1985) Elements of Micropaleontology. Springer Science & Business Media. Brasier, M.D. (1980) Microfossils. Chapman & Hall.

5. Ager, D.V. (1963) Principles of paleoecology: an introduction to the study of how and where animals and plants lived in the past. McGraw-Hill.

6. Clarkson, E.N.K. (1998) Invertebrate palaeontology and evolution (4th Edition). Wiley-Blackwell.

Course Title: Climate Change	
Course Code: OCN 4203	**Credit: 3.0**

PART A

1) Course Code: OCN 4203

2) Course Title: Global Climate Change

3) Course Type: CC

4) Year and Semester: Year 4, Semester 1

5) Prerequisite (if any): N/A

6) Credit: 3

7) Contact Hours: 42

8) Total Marks: 100

9) Course Summary and Objectives:

Climate change is the major challenge for humankind at present and even in near future. It has a great impact on every important sector of our life on earth, oceanic processes and atmosphere circulation patterns. Moreover, it is expected that extreme weather conditions will be more severe. So, it is very essential to have thorough knowledge about the trends of climate change, causes of climate change and impacts, for building up proper mitigation and adaptation capability. Course objectives include –

- To learn how the climate system works
- To understand the factors causing climate to change across different time scales and how these factors interact
- To know climate modeling for future prediction impacts of climate change
- To learn about different agreement for taking adaptation and mitigation measures against climate change

10) Course Learning Outcomes (CLO):

i. **CLO 1:** Demonstrate knowledge of the scientific principles and evidence underlying global trends of climate change.

ii. **CLO 2:** Learn the process of future prediction of climate change

iii. **CLO 3:** Evaluate strategies to enhance resilience and adaptive capacity against climate change across different sectors.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	3	1	3	3	2	3	2	2	3	2
CLO 2	2	1	3	2	2	3	2	2	3	2
CLO 3	2	2	3	3	2	3	3	3	3	3

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Module 1: Introduction to Climate and Climate Change What is Climate? Weather vs Climate The Earth's Climate System Historical Climate Changes (Paleoclimate overview) Overview of Anthropogenic Climate Change	Week-1	Lecture, Discussion	Assignment	CLO 1
2	Module 2: Earth's Energy Balance and Greenhouse Effect Solar radiation and Earth's energy budget Anthropogenic emissions	Week-2	Lecture, Discussion	Class performance and interactions	CLO 1, CLO 2
3	Module 2: Earth's Energy Balance and Greenhouse Effect (Part-02) Feedback mechanisms (e.g., water vapor, ice-albedo) Role of clouds and aerosols	Week-3	Lecture, Group Discussion	Class Test/Quiz-1	CLO 1, CLO 2
4	Module 3: Evidence of Climate Change Instrumental temperature records Melting glaciers, rising sea	Week-4	Lecture, Interactive discussion	Presentation, interactions	CLO 1, CLO 2

	levels Ocean warming and acidification Changes in biosphere and ecosystems Paleoclimate proxies (ice cores, tree rings)				
5	Module 4: Climate Change Drivers Natural Climate Change: Changes in Earth's solar input, Orbital and sub-orbital forcing, Milankovitch cycle Carbon cycle and sources/sinks of CO_2 Fossil fuel use, land use change, deforestation Role of methane, nitrous oxide, and other GHGs	Week-5	Power point presentation	Assignment	CLO 1, CLO 2
6	Module 5: Ocean and Climate Ocean's Heat budget Thermohaline Circulation: The Global Conveyor Belt Physical and biological pumps in the ocean	Week-6	Power point presentation	Oral viva, interactions	CLO 1, CLO 2, CLO 3
7	Module 5: Ocean and Climate (Part-02) Carbon cycle and climate	Week-7	Power point presentation	Sketching the diagrams	CLO 1, CLO 2, CLO 3
8	Mid-Term Examination Ocean-Climate Feedbacks	Week-8	- Power point presentation	- Sketching the diagrams	- CLO 2, CLO 3
9	Module 6: Climate Modeling and Projections Basics of climate models (GCMs, RCMs, ROMS)	Week-9	Lecture, Discussion	Class Test/Quiz-2	CLO 2, CLO 3
10	Module 6: Climate Modeling and Projections (Part-02) Climate scenarios (IPCC SSPs) Uncertainty in predictions Climate model limitations and improvements	Week-10	Lecture, independent reading	Group assignment	CLO 3
11	Module 7: Global Impacts of Climate Change Sea level rise, extreme weather, oceanic and atmospheric hazards Impacts on agriculture, water resources, and food security	Week-11	Power point presentation	Brain-storming and performance	CLO 3

	Health effects, biodiversity loss, climate migration & refugee				
12	Module 8: Climate Change Mitigation Emission reduction strategies (renewables, carbon pricing) Carbon capture and storage Energy efficiency and conservation Role of policy (Kyoto, Paris Agreement, IPCC Report)	Week-12	Power point presentation	Class Test/Quiz-3	CLO 3
13	Module 9: Climate Change Adaptation & Services Climate Service Adaptation planning and disaster risk reduction Ecosystem-based adaptation Urban planning and infrastructure resilience Indigenous knowledge and community adaptation	Week-13	Power point presentation	Group Discussion	CLO 1, CLO 3
14	Module 10: Climate Change Economics and Justice Climate financing (Green Climate Fund, loss & damage) Climate equity and environmental justice Role of developed vs developing nations	Week-14	Power point presentation	Group Presentation	CLO 1, CLO 2, CLO 3

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5			10
Understand		1	5		5	10
Apply	5	1			5	10
Analyze		1		2	5	15
Evaluate		1		2		10
Create				1		5

PART D

16) Reference Books:

- Climate Change: The Science of Global Warming and Our Energy Future, by Edmond Mathez, Columbia University Press (1st edition, 2009), ISBN: 0231146426.
- Climate Change: Picturing the Science, by Gavin Schmidt, Joshua Wolfe, and Jeffrey D. Sachs,W. W. Norton & Company (1st edition, 2009), ISBN: 0393331253.
- IPCC Assessment Reports (latest)
- *Climate Change: The Science of Global Warming and Our Energy Future* – Edmond A. Mathez
- Peer-reviewed journal articles and government reports

Course Title: Smart Technology	
Course Code: OCN 4205	**Credit: 2.0**

PART-A

1) Course Code: OCN 4205

2) Course Title: Smart Technology

3) Course Type: AC

4) Year and Semester: Year 4, Semester 1

5) Prerequisite (if any): N/A

6) Credit Value: 2

7) Contact Hours: 28

8) Total Marks: 100

9) Course Summary and Objectives

This course introduces students to modern smart technologies reshaping oceanographic research and maritime industries. It explores Internet of Things (IoT), autonomous systems, artificial intelligence, and big data tools applied to ocean monitoring, biodiversity, and smart infrastructure. Course objectives include –

- To understand key components of smart technologies used in ocean sciences and services.
- To explore the applications of IoT, robotics, and AI in marine monitoring and decision-making.
- To evaluate global and regional smart ocean projects including digital twins and smart ports
- To examine the challenges and opportunities of adopting smart technologies in Bangladesh's ocean sector.

10) Course Learning Outcomes (CLOs)

i. CLO 1: Describe core concepts of smart technology and their relevance to oceanography.
ii. CLO 2: Identify and interpret real-world examples of IoT, robotics, and AI in ocean monitoring.
iii. CLO 3: Analyze global smart ocean systems and evaluate their potential for local adaptation.
iv. CLO 4: Communicate findings from case studies on smart technology applications in ocean science.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	3	3	2	2	1	1	3	2	2	2
CLO 2	2	3	3	3	1	2	3	2	3	3
CLO 3	3	3	3	3	2	2	3	3	3	3
CLO 4	2	3	2	3	1	2	3	3	3	3

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques

Sl. No.	Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1	Introduction to Smart Technology in Oceanography	Week 1	Lecture + global case examples (NOAA, JAMSTEC, GEOMAR)	Class participation	CLO 1
2	Internet of Things (IoT) and Smart Sensor Networks, Underwater Drone Networks	Week 2	Demo of buoy-based IoT, reading discussions	Reflection note	CLO 2
3	Autonomous Vehicles: AUVs, ROVs, and Gliders, SMART cable.	Week 3	Case video walkthrough (Seaglider, Argo, Slocum)	Assignment	CLO 2
4	Robotics in Oceanography	Week 4	Lecture + robotics discussion	Short written task	CLO 2
5	Artificial Intelligence & Machine Learning in Ocean Sciences	Week 5	Case-based learning, AI demo	Class interaction	CLO 2, CLO 3
6	Smart Observatories	Week 6	Exploration of Digital Ocean projects	Quiz	CLO 1, CLO 3
7	Mid-Term Examination Digital Twin Ocean	Week 7	Written exam (short theoretical + applied) Presentation	Mid-term (15 marks) Class interaction	 CLO 1–3
8	Smart Technology in Marine Biodiversity Monitoring	Week 8	Example walkthroughs (eDNA, acoustic systems)	Class activity	CLO 2
9	Cloud Computing & Big Data in Ocean Science	Week 9	Intro to GEE, NASA OceanColor,	Practical task submission	CLO 3

			CMEMS data		
10	Smart Ports and Shipping	Week 10	Case lecture + Bangladesh relevance	Presentation	CLO 3
11	Satellite–IoT Integration for Ocean Monitoring	Week 11	Hybrid lecture with examples	Short quiz	CLO 1, CLO 2
12	Energy & Smart Technology at Sea	Week 12	Discussion on renewable tech buoys, wave-powered sensors	Group reflection	CLO 1, CLO 4
13	Ethical, Social, and Environmental Implications	Week 13	Discussion + examples (security, data sharing)	Essay or infographic	CLO 4
14	Course Wrap-Up & Final Project Presentation	Week 14	Student group presentation on smart technology case study	Final Presentation (20 marks)	CLO 4

PART C

13) Assessment and Evaluation

Bloom's Category	**Continuous Internal Evaluation**					**Semester Final Examination**
	Attend. (05)	**Class Performance (05)**	**Class Tests (10)**	**Assign. (05)**	**Mid Term (15)**	**Final (60)**
Remember		1	5			10
Understand		1	5		5	10
Apply	5	1			5	10
Analyze		1		1	5	10
Evaluate		1		2		10
Create				2		10

PART D

Suggested reading:

- **"Smart Ocean Systems"**, OceanObs19 Conference Reports – key readings on global smart observatory initiatives.
- **UNESCO/IOC Reports** on Digital Twin Ocean and Ocean Decade Technology Programs.
- **FAO and NOAA Technical Papers** on the use of smart tech for biodiversity and fisheries monitoring

Course Title: Research Project	
Course Code: OCN 4207	**Credit: 4.0**

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 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 BMU Authority.

2. Thesis students shall follow relevant instructions of BMU Examination Regulation.

Course Title: Viva-voce	
Course Code: OCN 4208	**Credit: 2.0**

PART-A

1) **Course Code:** OCN 4208

2) **Course Title:** Viva-Voce

3) **Course Type:** FC

4) **Year and Semester:** Year 4, Semester 2

5) **Prerequisite (if any):** N/A

6) **Credit Value:** 2

7) **Contact Hours:** N/A

8) **Total Marks:** 100

Viva voce will be conducted towards the end of the academic year which will be covering the complete syllabus. This will assess the student's knowledge and understanding during the course of their graduate programme. In doing so, the main objective of this course is to prepare the students to face interview both at the academic and the professional arenas.

9) **Course Objectives:**

The primary aim of the course is to develop students' confidence in oral assessments and to evaluate the conceptual understanding gained during their first year of undergraduate education.

10) **Course Learning Outcomes (CLOs):**

Upon successful completion of the course the students will be able to:

i. CLO1: To describe and explain their understanding of the theoretical and practical fundamental courses.
ii. CLO2: Get prepared to face the interview both at the academic and the professional arenas.

11) Mapping of CLOs with Program Learning Outcomes (PLOs):

PLO / **CLO**	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	**3**	2	**3**	**3**	2	2	2	**3**	2	2
CLO 2	2	2	2	2	2	2	2	**3**	2	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) **Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques**

Course Contents	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1. Comprehensive assessment of all courses offered in the first year, spanning both the first and second semesters.	Viva	Oral Exam	CLO 1, CLO 2

Course Title: Field Work IV: Advanced Field Oceanography	
Course Code: OCN 4209	**Credit: 2.0**

PART A

1) **Course Code:** OCN 4209

2) **Course Title:** Advanced Field Methods in Oceanography

3) **Course Type:** SKD

4) **Year and Semester:** Year 4, Semester 2

5) **Prerequisite (if any):** N/A

6) **Credit Value:** 2

7) **Contact Hours:** 42

8) **Total Marks:** 100

9) **Course Summary and Objectives:**

This course would provide knowledge and hands-on experience of oceanographic processes and morphology of the coastal zone and sampling techniques of basic parameters from Physical, Chemical and Ecological arena. It introduces students to the study of coastal oceanic process with a focus on physical, chemical and geomorphological processes in the nearshore and how various ecosystems response with those changes/processes.

- Learn hands-on sampling techniques and study area determination.
- Gain knowledge about coastal process (physical, chemical, geomorphology) and ecosystems
- Learn scientific methods of biological sample preservation and systematics approaches of its identification.
- Identify the primary processes that shape the coastal zone and drive changes in coastal morphology

10) **Course Learning Outcomes (CLO):**

i. CLO 1: Learn hands-on sampling techniques of physico-chemical, biological, and geological sample and preservation.
ii. CLO 2: Gain knowledge about coastal process (physical, chemical, geomorphology) and ecosystems.
iii. CLO 3: Learn ecosystem structure and ecosystem services of coastal estuarine mangrove forest.
iv. CLO 4: Learn estuarine biodiversity hotspot and their relationship with physicochemical parameters.

11) **Mapping of CLOs with Program Learning Outcomes (PLOs):**

PLO / CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	3	2	1	2	3	3	3	3	2	1
CLO 2	2	1	2	2	2	3	3	3	3	2
CLO 3	2	3	1	3	3	2	3	3	3	2
CLO 4	1	3	2	2	3	3	3	2	3	2

(Weightage: 3-High, 2-Medium, 1-Low)

PART B

12) **Course contents and alignments with CLOs, weekly plan, teaching-learning strategies, and assessment techniques**

Course Contents	Time Frame	Teaching Strategies	Assessment Strategies	Alignment with CLOs
1. Introduction to oceanographic instruments 2. Deployment of oceanographic instrument and data acquisition techniques 3. Safety management during oceanographic sampling		Lectures, Hands-On	Field Performance, Report submission, Presentation	CLO 1, CLO 2, CLO 4
Selection of study area 4. Sampling techniques of physical, chemical parameters 5. Biological sampling techniques, preservation method and identification 6. Survey of ecosystem services of mangrove ecosystem 7. Biodiversity hotspot identification 8. Pollution hotspot identification		Lectures, Hands-On	Field Performance, Laboratory evaluation, Report submission	CLO 1, CLO 2, CLO 3, CLO 4

PART C

13) Assessment and Evaluation

Bloom's Category	Semester Final Examination			
	Attendance (10)	Field Performance (30)	Report (40)	Presentation / Viva (20)
Remember		5	5	5
Understand		5	5	5
Apply	10	5	5	5
Analyze		5	5	5
Evaluate		5	5	
Create		5	5	

PART D

14) Reference Books

- Introduction to Coastal Processes and Geomorphology, by Robin Davidson-Arnott, Cambridge University Press, ISBN: 0521696712.
- Beach Processes and Sedimentation (2nd Ed.) by Paul Komar, 1998, Prentice-Hall
- Fundamental of Ecology by Odum.
- Sundarbans Mangrove: Fish and Fisheries – Ecology, Resources, Productivity and Management Perspectives by M. Enamul Hoq (2008)

Admission Criteria

A. Admission Criteria

Applicants must fulfil the admission requirements as prescribed by Bangladesh Maritime University (BMU). To be eligible for admission in the programme, a candidate must pass SSC/Dakhil and HSC/Alim examinations or its equivalent in Science discipline. The minimum requirements for admission in this programme are as follows:

i. Applicants who have passed HSC or equivalent examination in the current year or one year before the notification for admission are eligible to apply.
ii. 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. Applicants must have Biology in HSC.
iii. In HSC/Alim/equivalent examination the applicant must have obtained minimum "A" grade in any two (02) subjects from Mathematics, Physics, Chemistry, Biology and English with minimum "B+" (B plus) grade in rest of the Courses.
iv. Applicants with GCE must have passed minimum five subjects in O level including Physics, Chemistry, Mathematics and at least two subjects in A level including Physics and Mathematics. Applicants must also have Biology in A level. However, an applicant having more than two 'C' grades in O level and/or more than one 'C' grade in A level shall not be eligible for admission.

B. Admission of Foreign Students

Foreign applicants shall apply through their respective embassy. Educational qualifications are same as applicable for Bangladeshi students. International Students Support Centre (ISSC) of the university will deal with the admission procedure and welfare of the international students.

C. Admission Test

The admission notice shall be circulated usually in the month of August/September of each year through media advertisement, BMU website and notice board. The procedure for admission in BSc in Oceanography programme is as follows:

C.1 Written Admission Test

An eligible candidate have to sit for a written admission test of 100 marks. The current HSC syllabus shall be the syllabus of the admission test.

C.2 Marks Distribution of Written Admission Test

Subjects of the written examination and mark distributions are given below:

(1)	Mathematics	:	20 marks
(2)	Physics	:	20 marks
(3)	Chemistry	:	20 marks
(4)	Biology	:	20 marks
(5)	English	:	20 marks
Total		**:**	**100 marks**

C.3 Final Selection

Candidates will be selected finally on the basis of their combined marks obtained in the written admission test (100), HSC/equivalent examination (60) and SSC/equivalent examination (40). Final merit list along with waiting list will be published on BMU notice board as well as on BMU website.

D. Registration/Admission in the Programme

After final selection, selected candidates shall be registered with the programme in accordance with the procedures as laid down by BMU. The candidates have to go through a medical checkup at BMU 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.

E. Cancellation of Admission

Procedure for cancellation of admission is given below:

i. If any candidate fails to complete admission formalities within the prescribed date and time, his/her selection will be cancelled automatically without any notice;
ii. If any student fails to report or does not attend the class within two weeks of commencement of classes, his/ her admission will be cancelled automatically without any notice. In such cases, students from the waiting list will be called to fill the vacancy.

F. Re-admission

i. 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. S/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 s/he shall be dropped out of the program. If are admitted student earns required GPA for promotion as an irregular candidate in 1st to 8th-semester examination, but failed in any course/s, s/he shall not be allowed to appear in the failed course/s to improve GPA under any consideration.
ii. Re-admission will not be allowed in the 1st semester, if the percentage of class attendance of the student is below 30, then his/her studentship will be treated as cancelled, i.e. s/he will be dropped out of the program.
iii. A student may be allowed re-admission for not more than once in a particular semester and not more than twice in the entire program.