Curriculum
MSc in Naval Architecture and Offshore Engineering Programme

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AUTHOROTY OF PUBLICATION

1. A Curriculum committee formed vide memorandum no. BSMRMU/VC Office/Admin-11/22/133 dated 08 September 2022 drafted the curriculum of MSc in Naval Architecture & Offshore Engineering [Committee approved by syndicate meeting vide memorandum no. BSMRMU/Reg/Council/Syndicate-377/2023/186 dated 24 January 2023]. The committee comprises with the following members:

a. Dr. Md Sadiqul Baree - President
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b. Commodore M Ziauddin Alamgir,(Retd), BN - Member
Dean, Faculty of Engineering and Technology
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c. Commodore Md. Munir Hassan (Retd), BN - Member
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d. Dr. Goutam Kumar Saha - Member
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e. Dr. Mir Tareque Ali - Member
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f. Dr. Md. Mashiur Rahman - Member
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g. Commander Saiful Ahmad, (E), PCGMS, BN - Member
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h. Dr. S M Rashidul Hasan - Member
Assistant Professor
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2. After review curriculums of similar programs from several renowned universities of home and abroad a draft curriculum was prepared by the curriculum committee and submitted to the Academic Council for approval.

3. After incorporation of the suggestion of the Academic Council (38th meeting held on 09 March 2023. Item No-01), the curriculum was presented to the syndicate (34th meeting held on 17 April 2023). The syndicate approved the curriculum with some amendments/suggestions.

4. Based on the amendment /suggestion the curriculum was finalized and published here.

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INTRODUCTION TO THE UNIVERSITY

Background

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

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

Vision

Vision of the University is to promote and create a learning environment for higher maritime education with excellence, strengthened by learned and competent faculties, appropriate academic facilities and infrastructure of global standards and expanded frontier research based knowledge supportive of the new horizons in diverse maritime fields as conceived by vision 2041.

Mission

M-1: BSMRMU is committed to ensure quality maritime education and facilitate scholarly research responsive to the emerging global challenges and modern technology.

M-2: The University is dedicated to nurture and develop competent maritime professionals with strong sense of ethical values, patriotism and inspiring leadership ready to face the competitive maritime world in achieving vision 2041.

Goals

Goals of the University are as follows:

- Achieve sustainable development and progress of the university through mutual cooperation with other related universities/ institutions.
- Continue to upgrade educational services and facilities responsive to the demands and requirements of the nation.
- Bring all types of marine professionals on a common platform to share knowledge and perform research and development works for the advancement of country's maritime sector.
- Enhance research consciousness in the maritime sector in discovering new dimensions with the upcoming challenges.
- Accelerate the participation of alumni students and professionals with educational programs and development of projects designed to expand and improve academic standards.
- Teach students on marine science and technology and guide them towards research to enhance contribution to the maritime profession.
- Conduct various educational programmes and research works for sustainable development of the maritime service and industrial sector of the country.
- Educate students on different subjects of maritime management, law and security and strategy and conduct research on allied fields.
- Create conducive environment for students to prepare themselves to serve the nation as future planners/ policy makers/ leaders in maritime sectors in coordination with national and international organizations including International Maritime Organization (IMO).

INTRODUCTION TO THE FACULTY

The objective of the Faculty of Engineering and Technology (FET) is to provide outstanding engineering education directed at enriching the quality of life in an emerging knowledge-based society. The mission of the faculty is to produce highly competent engineering graduates, who can conduct internationally recognized research and provide quality professional services.

Faculty of Engineering and Technology comprises of the following departments:

- Naval Architecture and Offshore Engineering
- Ocean Engineering
- Marine Engineering
- Harbour and River Engineering
- Electrical and Electronics Engineering
- Telecommunication Engineering
- Control Engineering & Mechatronics

INTRODUCTION TO THE DEPARTMENT

The Department of Naval Architecture and Offshore Engineering is increasingly vital in the search for energy resources in context of Blue Economy. However, Bangladesh is yet to have any formal education in this sector. To fill this gap, the only specialized public maritime university BSMRMU has introduced the Department of Naval Architecture and Offshore Engineering. The department will help the nation to meet the engineering needs of the maritime and offshore industries by providing specialized knowledge pertinent to these industries.

The department conducts both undergraduate and post graduate programmes in Naval Architecture and Offshore Engineering.

VISION OF THE DEPARTMENT

Aiming to develop young brains into ones that are academically smart, technically inventive, morally sound, emotionally strong, and beneficial to society. Bring in quality education and research that meets the highest international standards.

MISSION OF THE DEPARTMENT

MOD-1: The Department is focused on using the "learn by doing" approach to assist students put their newfound knowledge into practice.

MOD-2: The Department is dedicated to providing high quality education and research in the maritime sector.

MOD-3: The department is dedicated to enhancing students' numerical and analytical abilities so they can be more successful in innovation and research.

MOD-4: To take on various initiatives to aid in the design and research activities that assist graduates in furthering their education and career development.

MOD-5: To develop world-class research capabilities in the areas of offshore engineering and naval architecture.

MOD-6: To improve the field of naval architecture through education based on practical experience.

OBJECTIVE OF THE PROGRAMME

PO-1: To find, teach, and support outstanding, diverse students, encourage lifelong learning and accomplishment, and position them for sustained careers as leaders in engineering in the marine-related fields of business, government, and academia.

PO-2: To uphold and improve the top undergraduate program in naval architecture and marine engineering in the world, one that offers rigorous and efficient is training for a lifetime in engineering leadership and service.

NAME OF THE DEGREE

Master of Science in Naval Architecture and Offshore Engineering (MSc in NAOE).

DESCRIPTION OF THE PROGRAMME

Master of Science in Naval Architecture and Offshore Engineering (NAOE) programme is a **1.5**-year full time regular postgraduate programme. Graduates from this programme will be able to develop their careers as Offshore Engineer, Naval Architect, Structural Engineer, Scientist and Project Manager in the relevant discipline. In their challenging career, they will be able to design, plan, and manage the construction, installation, operation, and maintenance of ships and offshore infrastructures and systems.

GRADUATE ATTRIBUTES

Learning Outcome Domains	Level Descriptors
Fundamental Skills	1. Demonstrate knowledge and critical understanding of the well-established principles of his/her field of study, and of the way in which those principles have developed. 2. Apply knowledge and skills in addressing issues/solving problems with minimal supervision. 3. Evaluate critically the appropriateness of different approaches to solving problems in his/her field of study;
Social Skills	1. Communicate and interact effectively and clearly, ideas, information, problems, and solutions as a team to peers, experts and non-experts. 2. Produce clear, well structured, detailed text on complex subjects, showing controlled use of organizational patterns, connectors, and cohesive devices in advanced proficiency level;
Thinking Skills	1. Exercise very substantial degree of autonomy and often significant responsibility in making judgments/ decisions towards the management of self, others and for the allocation of substantial resources; and 2. Demonstrate professional knowledge and practical skills in both technical and management to lead a team in inexperienced environment.
Personal Skills	1. Engage in self-direction and self-enterprise skills. 2. Demonstrate social, professional, environmental and ethical practice/ values. 3. Show-case global knowledge and competencies to fulfill employment, entrepreneurial and lifelong learning skills; and 4. Contribute significantly to the society.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO-1: To enable students to design a wide range of marine vehicles, coastal structures, and offshore structures,

PEO-2: To provide students with a solid foundation in engineering fundamentals that will enable them to learn throughout their lives with strong ethical values, patriotism and help them solve problems and make

decisions,
PEO-3: To teach students how to deal with conflict, work in teams with people from different backgrounds because of the different areas where they work, and care about the environment and other contemporary issues,
PEO-4: To graduate students with advanced writing and oral presentation abilities and access to cutting-edge engineering tools,
PEO-5: To encourage our graduates to pursue careers in academia, research, and graduate studies.

PROGRAMME LEARNING OUTCOME (PLOs)

On completion of the programme, graduates will be able to:

PLO-1: Acquire advanced knowledge and skills to further develop and utilize these for new situations in ship and offshore engineering.
PLO-2: Formulate engineering problems and develop practical solutions.
PLO-3: Extract data pertinent to an unfamiliar problem and interpret the results of engineering experiments appropriate for Naval Architecture and Offshore Engineering
PLO-4: Design and analyze products and processes involved in naval architecture and offshore engineering.
PLO-5: Work effectively in teams and provide leadership.
PLO-6: Understand the impact of engineering decisions in a global/societal/environmental context.
PLO-7: Recognize the managerial, professional, and ethical responsibility.
PLO-8: Identify the necessity to adopt latest knowledge and technologies through lifelong learning.
PLO-9: Apply critical thinking and problem-solving skills in addressing naval architecture and offshore engineering problems utilizing relevant tools and techniques.
PLO-10: Effectively communicate to share ideas/solutions orally, graphically and in writing.
PLO-11: Apply mathematical and computer-based models for solving problems associated with ship and offshore structures, and the ability to assess the limitations of cases.

MAPPING MISSION OF THE UNIVERSITY WITH PEOs

PEOs	Mission 1	Mission 2
PEO-1	✓	
PEO-2	✓	✓
PEO-3		✓
PEO-4	✓	
PEO-5	✓	

Correlation: 3 – High, 2 – Medium, 1 – Low

MAPPING PLOs WITH THE PEOs

PLOs	PEO-1	PEO-2	PEO-3	PEO-4	PEO-5
PLO-1	✓	✓			
PLO-2	✓	✓			
PLO-3					✓
PLO-4	✓	✓			
PLO-5			✓	✓	
PLO-6			✓		
PLO-7		✓	✓		
PLO-8	✓				✓
PLO-9				✓	
PLO-10				✓	
PLO-11	✓	✓			

Correlation: 3 – High, 1 – Low

MAPPING COURSES WITH PLOs

Course Code	Course Name	Programme Outcomes										
		PLO-1	PLO-2	PLO-3	PLO-4	PLO-5	PLO-6	PLO-7	PLO-8	PLO-9	PLO-10	PLO-11
NAOE 6101	Dynamics of Ship and offshore Structures	✓	✓		✓				✓	✓		✓
NAOE 6103	Advanced Marine Hydrodynamics	✓	✓	✓					✓	✓		
NAOE 6105	Advanced Numerical Methods in Marine Application	✓	✓						✓	✓		✓
NAOE 6201	Sea Keeping Performance	✓	✓		✓				✓	✓		✓
NAOE 6203	Research Methodology	✓	✓	✓			✓		✓	✓	✓	✓
NAOE 6205	Student Concluding Seminar		✓			✓		✓			✓	
NAOE 61xx	Optional – I	✓			✓				✓	✓		
NAOE 62xx	Optional – II	✓			✓				✓	✓		
NAOE 6002	Field Trip					✓						
NAOE 6000	Thesis	✓	✓	✓			✓	✓	✓	✓	✓	✓

STRUCTURE OF THE CURRICULUM

The programme is divided into 3 semesters of six months each. The total credit hour of this programme is 40 including 18 credit hours for the thesis. Besides regular courses, workshops, seminars, guest lectures on contemporary issues are arranged frequently for the students. The duration of each semester is 26 weeks. Each semester is distributed as follows:

a.	Classes	14 weeks
b.	Mid Term Examinations	02 weeks
c.	Preparatory Leave	02 weeks
d.	Final Examination	03 weeks
e.	Recess	04 weeks

ADMISSION REQUIREMENT

Admission Criteria

Eligibility for admission in Naval Architecture & Offshore Engineering programme is as follows:

a. Applicants who have passed four years B.Sc. Engg. or equivalent examination with a minimum CGPA of 2.5 out of 4.0 or at least 50% marks in Naval Architecture and Offshore Engineering/ Naval Architecture and Marine Engineering/ Mechanical Engineering/ Ocean and Offshore Engineering/Related Engg. degree

b. Applicants must have passed HSC/equivalent examination and SSC/equivalent examination from science group with minimum GPA 4.00.

c. In HSC/equivalent examination, applicants must have obtained minimum 'A' grade in any two subjects from Mathematics, Physics, Chemistry and English with minimum 'B' grade in rest of the subjects.

d. Applicants with GCE must have passed minimum five subjects in O-Level including Mathematics, Physics and Chemistry and minimum two subjects in A-Level including Mathematics and Physics. However, an applicant having more than two 'C' grades in O-Level and/or more than one 'C' grade in A-Level will be ineligible for admission.

Admission Procedure

The procedure for admission in MSc in Naval Architecture & Offshore Engineering programme is as follows:

a. **Admission Circular:** BSMRMU will invite applications from interested candidates for admission in MSc in Naval Architecture & Offshore Engineering programme by publishing advertisements in the national dailies and BSMRMU website.

b. **Admission Test:** All eligible applicants shall be required to appear the admission test as per BSMRMU admission policy/regulations for Master of Science in Naval Architecture & Offshore Engineering. Admission test shall normally be comprised of written test and viva voce. Only written test qualified applicant shall be called for viva voce.

c. **Final Selection:** The final selection for admission shall be based on the Admission Test result. Selected candidates shall be registered with the programme in accordance with the procedures as

laid down by BSMRMU. The final merit list along with the waiting list will be published on the BSMRMU notice board as well as on the BSMRMU website.

Registration in the Programme

After final selection, the selected candidates will be registered under the programme in accordance with the procedures as laid down by BSMRMU. The candidates have to go through a medical checkup at BSMRMU designated Medical Centre to ascertain their medical fitness. The selected candidates have to collect Admission Form from the Admission Section, and complete admission and registration formalities within the given time frame by paying the required fees. The following rules will apply in this regard:

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

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

Minimum Credit Requirement to complete the programme

Theory 22 Credits, Thesis 18 Credits
Total 40.0 Credits

The Requirements for Promotion to the Next Semester

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

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

b. A student will be promoted to the second semester of each year, irrespective of his/her results in the first semester of the year.

The Requirements for Promotion to the Next Year

The requirements for promotion to the next year are as follows:

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

b. A student will be promoted to the next year, provided he/she does not have 'F' grades in more than two subjects including backlog subjects (if any).

The Reexamination of Failed Subjects

Normally the re-examination of the failed subjects will be conducted at the beginning of the following academic year. A short term may be conducted for them during year ending recesses. However, students may also opt to register the failed subjects and appear the examination with next batch.

TEACHING STRATEGY

The teaching strategy of the programme is mainly lecture based for theoretical courses and demonstration for lab courses. Other teaching strategy includes case study, group discussion, workshop, seminar and field work learning etc.

Assignment of Credits

a. For theoretical courses, one lecture of 50 minutes per week per term is equivalent to one credit hour.

b. For laboratory courses, 100 minutes per week per term is equivalent to one credit hour.

c. Credit hours are also assigned to study tour, industrial attachment, project and thesis work taken by the students. The amount of time assigned to such work may vary depending on the requirements.

Conduct of Courses

The following guidelines will be followed for conducting the courses:

a. At the beginning of the term, 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. Project and thesis work will be assigned, either individually or in groups on any issue pertaining to the course.

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

ASSESSMENT STRATEGY

Grading System

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

Letter Grade	Grade points	Numerical Markings
A+	4	80% and above
A	3.75	75% to below 80%
A-	3.5	70% to below 75%
B+	3.25	65% to below 70%
B	3	60% to below 65%
B-	2.75	55% to below 60%
C+	2.5	50% to below 55%
C	2.25	45% to below 50%
D	2	40% to below 45%
F	0	below 40%
X	Thesis/Project continuation	-

PERFORMANCE EVALUATIONS

Theory Courses

Forty percent (40%) marks of theoretical course will be allotted for continuous assessment, i.e. quizzes, class tests, assignments, class evaluation, class participation, mid-term exam etc. Term Final Examination is conducted centrally by BSMRMU. Term Final Examination will be normally of 3-hour duration and comprise of 60% marks. Distribution of marks for a given course is as follows:

a. Class Attendance : 05%

b. Class Participation/Observation : 05%

c. Term Paper/Assignment : 05%

d. Class Tests/Quiz : 10%

e. Mid Term Examination (01 Exam) : 15%

f. Term Final Examination : 60%

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

Thesis

The distribution of marks for the performance evaluation of the thesis is given below:

a. Report Submission : 50%
b. Presentation : 30%
c. Oral Examination : 20%

Skill Development Course

Developing Course is comprised of two items:

a. Field trip/ study tour
b. Student concluding seminar.

The performance of the field trip/ study tour of each student will be evaluated as follows:

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

The performance of the Student Concluding Seminar of each student will be evaluated as follows:

a. Attendance 10%
b. Submission of Paper 30%
c. Presentation 40%
d. Handling Questionnaire 20%

Credit Earned

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

Degree Requirements

Degree requirements are as follows:

a. Completion of courses required for fulfilling the minimum credit hours of 40 (including a thesis of 18 credit hours) in a maximum period of 3.0 (Three) academic years from the date of the first admission.

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

c. Successful defence of thesis paper.

d. Scoring a CGPA 2.20 or above.

COURSE DESIGNATION SYSTEM

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

a. The first digit corresponds to the postgraduate level studies.
b. The second digit corresponds to the semester in which the course is normally taken by the students.
c. The last two digits denote corresponding course.

CURRICULUM STRUCTURE

MSc in NAOE programme consists of total 08 theory courses excluding non-credit courses and thesis. The courses are divided into the following categories:

Category	No. of Theory Courses	No. of Research/Lab/practical Courses	No. of non-credit courses	Credit Hours
Core Courses	04	00	00	12.0
Optional Courses	02	00	00	6.0
Development Courses	02	00	01	4.0
Thesis	00	01	00	18.0
Total	**08**	**01**	**01**	**40.0**

1 Semester wise Course Schedule

Semester-1			
Course Code	**Course Name**	**Type**	**Credit Hours**
NAOE 6101	Dynamics of Ship and offshore Structures	Core Course	3.0
NAOE 6103	Advanced Marine Hydrodynamics	Core Course	3.0
NAOE 6105	Advanced Numerical Methods in Marine Application	Core Course	3.0
DEV 6101	Research Methodology	Development	3.0
DEV 6103	Student Concluding Seminar	Development	1.0
		Total	**13.0**

Semester-2			
Course Code	**Course Name**	**Type**	**Credit Hours**
NAOE 6201	Sea Keeping Performance	Core Course	3.0
NAOE 62XX	Optional – I	Optional Course	3.0
NAOE 62XX	Optional – II	Optional Course	3.0
NAOE 6000	Thesis	Research	6.0
		Total	**15.0**

Semester-3			
Course Code	**Course Name**	**Type**	**Credit Hours**
NAOE 6000	Thesis	Research	12.0
NAOE 6002	Field Trip	Development	0.0
		Total	**12.0**

Grand Total: 40.0 Credits

List of Optional Theory Courses:

Students will take two optional theory courses in the third semester from the following list:

Semester	Course Code	Course Name
Semester-2	NAOE 6203	Offshore Renewable Energy
	NAOE 6205	Turbulence Modeling
	NAOE 6207	Advanced Maritime Economics
	NAOE 6209	Marine Pollution
	NAOE 6211	Vibrations and Noises in Marine Structures
	NAOE 6213	Composite materials for marine application
	NAOE 6215	Hydrodynamic Loading of Marine Structures
	NAOE 6217	Finite Element Methods for Marine structures
	NAOE 6219	Analysis and Design of Welded Structures
	NAOE 6221	Advanced Marine Engineering
	NAOE 6223	High Speed Marine Vehicles
	NAOE 6225	Offshore Drilling and Subsea Engineering
	NAOE 6227	Artificial Intelligence for Maritime Applications
	NAOE 6229	Mooring and Riser Analysis

2 Course Profile

2.1 Core Courses (NAOE)

2.1.1 NAOE 6101: Dynamics of Ship and offshore Structures

Credit Hour: Three (3.0)
Contact: Hour: Three (3.0) per week

Rationale of the Course:

Higher education of Naval Architecture and Offshore Engineering requires in depth knowledge in different types of ships and offshore structures and their design. In addition, they shall be able to calculate the environmental loads acting on ships and offshore-structures based on hydrodynamic design. In that context, this is a mandatory course to be taught for MSc graduates of Naval Architecture and Offshore Engineering.

Course Content:

Classification of different types of ships and offshore structures and their conceptual design. Features of Drilling and production rigs, fixed structures, floating structures, complaint structures, linked multi-body systems. Comparison of different designs of offshore production platforms. Analysis of Fundamentals of hydromechanics, Wave theories; Hydrostatic Analysis, Hydrostatic forces, and stability of offshore structures; Hydrodynamic Analysis, Wave forces on hydro dynamically transparent structures, Motion of hydro dynamically transparent structures in a seaway, Forces and motions of hydrodynamically compact structures in a seaway.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Ability to identify the different types of ships and offshore structures.
LO-2	Ability to compare different types of ships of offshore structure design
LO-3	Ability to explain different wave theories related to ship and offshore structure design.

LO-4	Ability to calculate the environmental loads acting on ships and offshore-structures.
LO-5	Ability to apply hydrodynamic theories to understand the working principles of the ships and offshore structures.
LO-6	Ability to analyze the loads on the ships and offshore-structures based on hydrodynamic design.

Assessment Strategy:

Continuous Assessment (40 Marks)

Bloom's Category Marks	Class Test/ Quiz (10)	Term Paper/Assignment (5)	Mid Term (15)	Remarks
Remember	✓			10 Marks is allocated for Attendance & Participation
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Semester Final Examination (60 Marks)

Bloom's Category	Test
Remember	5
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	10

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1-2	Class Test	5%	
LO 1-3	Class Test & Assessment	5%	
LO 1-4	Term Paper	5%	
LO 1-5	Mid Term	15%	
LO 1-6	Attendance/ Class Participation /Final Exam	70%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓										
LO 2	✓										
LO 3	✓										
LO 4	✓										
LO 5	✓										
LO 6	✓										

Reference Book:

1. Advanced Marine Structures, Srinivasan Chandrasekaran, CRC Press
2. Offshore Engineering: An Introduction, Angus Mather, Wither by& Co Ltd
3. Hydrodynamics of Offshore Structures, S.K. Chakrabarti, WIT press
4. Marine Structural Design Calculations, Mohamed A. El-Reedy, Butterworth-Heinemann.
5. Essentials of Offshore Structures: Framed and Gravity Platforms, D.V. Reddy, A. S. J. Swamidas, CRC Press.
6. Conference and Journal papers.

2.1.2 NAOE 6103: Advanced Marine Hydrodynamics

Credit Hour: Three (3.0)
Contact: Hour: Three (3.0) per week

Rationale:

Since marine vehicle moves through the water (or fixed in some cases) knowledge in hydrodynamics is mandatory. BSc graduates of Naval Architecture and Offshore Engineering have basic knowledge of Marine Hydrodynamics. However, for MSc graduates, higher level of knowledge is required.

Course Content:

The Motion of a Viscous Fluid: Description of flow, Conservation of Mass and Momentum, Transport Theorem, Continuity Equation, Euler's Equation, Stress relations in a Newtonian fluid, Navier-Stokes Equation, Laminar Boundary Layers: Steady Flow,past a flat plate, Turbulent Flow: General Aspects, Turbulent Boundary Layer on a flat plate.

Lifting Surfaces: Two dimensional Hydrofoil Theory, Linearized Two-dimensional Theory, The lifting Problem, Simple Foil Shapes, Drag force on a Two-dimensional foil, Two-dimensional Source and Vortex Distributions, Singular Integral Equations, Three dimensional Vortices, Three dimensional planar lifting surfaces, Induced Drag, Lifting line theory, Cavity flows, Symmetric Cavity flows, Super-cavitating Lifting foils, Unsteady Hydrofoil theory.

Hydrodynamics of Slender Bodies: Slender Body in an Unbounded Fluid, Longitudinal Motion, The Lateral Force, Ship Maneuvering: The Hydrodynamic Forces, Ship Maneuvering: The equations of Motion, Slender Bodies in Waves, Strip Theory for ship Motions, Slender Bodies in Shallow water.

Experimental Hydrodynamics: Techniques for model construction: modeling law, model design. Typical model tests: resistance, propulsion, propeller open water, cavitation tests, sea keeping tests, tests with slender structures. Uncertainty Analysis. Error sources in experiments. Special considerations for full scale measurements.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Describe the flow around bluff and streamlined bodies and discuss the benefits of streamlining,
LO-2	Calculate the pressure distribution and wake field around a submerged body in fluid,
LO-3	Apply fluid flow principles, including conservation of mass, momentum and energy, Bernoulli's principle, the stream and potential functions and sources and sinks, to assess the forces applied by the flow to submerged bodies in fluid,
LO-4	Estimate the wave-induced loads on simple geometric shapes and find the equations of motions of floating structures like that of ship,
LO-5	Apply dimensional analysis to theory and model testing,
LO-6	Estimate ship seakeeping response.

Assessment Strategy:

Continuous Assessment (40 Marks)

Bloom's Category Marks	Class Test/ Quiz (10)	Term Paper/Assignment (5)	Mid Term (15)	Remarks
Remember	✓			10 Marks is allocated for Attendance & Participation
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Semester Final Examination (60 Marks)

Bloom's Category	Test
Remember	5
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	10

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1-2	Class Test	5%	
LO 1-3	Class Test/Quiz/Assignment	5%	
LO 1-4	Term Paper	5%	
LO 1-5	Mid Term	15%	
LO 1-6	Attendance, Class Participation & Final Exam	70%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓										
LO 2	✓										
LO 3		✓									
LO 4				✓							
LO 5											✓
LO 6									✓		

Reference Book:

1. Practical Ship Hydrodynamics by V. Bertram, 2nd Edition, 2000.
2. Newman, J. N. *Marine Hydrodynamics*. Cambridge, MA: MIT Press, 1977. ISBN: 9780262140263.

(Not required - however, readings are assigned.)

3. Sabersky, R. H., A. J. Acosta, E. G. Hauptmann, and E. M. Gates. *Fluid Flow*. 4th ed. Upper Saddle River, NJ: Prentice Hall, 1998. ISBN: 9780135763728.
4. Introduction to Naval Architecture, by Thomas Gillmer and Brue Johnson, Naval Institute Press, Annapolis. Maryland

2.1.3 NAOE 6105: Advanced Numerical Methods in Marine Application

Credit Hour: Three (3.0)
Contact: Hour: Three (3.0) per week

Rationale:

Numerical methods provide a way to solve problems quickly and easily compared to analytic solutions. Whether the goal is integration or solution of complex differential equations, there are many tools available to reduce the solution of what can be sometimes quite difficult analytical math to simple algebra. This course will help NAOE graduates to develop different types of numerical tools to calculate Naval Architecture/Offshore Engineering problems.

Course Content:

Numerical error analysis; Consistency, stability and convergence of numerical methods; Numerical methods for boundary value problems: shooting, parallel shooting and finite difference methods for linear and nonlinear problems; Numerical methods for matrix eigenvalue problems: power method and its variants; Iterative methods for solving linear systems: Jacobi, Gauss-Seidel and SOR methods; Numerical methods for initial value problems: Euler, Taylor, Runge-Kutta, multistep, predictor-corrector methods; Nonlinear systems and optimization: Newton's method for nonlinear systems, unconstrained optimization, and constrained optimization; Fourier transform: Discrete Fourier Transform (DFT) and trigono- metric interpolation, and the fast Fourier transform.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	During the lecture the student understands the nature and operations of Numerical Analysis, demonstrates familiarity with theories and concepts used in Numerical Analysis, and identifies the steps required to carry out a piece of research on a topic in Numerical Analysis.
LO-2	By the end of the course the student is expected to recognize and apply appropriate theories, principles and concepts relevant to Numerical Analysis, critically assess and evaluate the literature within the field of Numerical Analysis, analyze and interpret information from a variety of sources relevant to Numerical Analysis.
LO-3	By the end of the course student will have the ability to compare the computational methods for advantages and drawbacks, choose the suitable computational method among several existing methods, implement the computational methods using any of existing programming languages, testing such methods and compare between them, identify the suitable computational technique for a specific type of problems, and develop the computational method that is suitable for the underlying problem.
LO-4	Within the lectures the student is able to transfer ideas and experience, work effectively as a part of a group and independently.

Assessment Strategy:

Continuous Assessment (40 Marks)

Bloom's Category Marks	Class Test/ Quiz (10)	Term Paper/Assignment (5)	Mid Term (15)	Remarks
Remember	✓			10 Marks is allocated for Attendance & Participation
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Semester Final Examination (60 Marks)

Bloom's Category	Test
Remember	5
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	10

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1	Class Test	5%	
LO 1-2	Class Test, Assignment, Class Participation & Term Paper	10%	
LO 1-3	Mid Term	15%	
LO 1-4	Attendance, Class Participation & Final Exam	70%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓										
LO 2		✓		✓							
LO 3											
LO 4					✓						

Reference Book:

1. J.H. Mathews and K.D. Fink, Numerical Methods using MATLAB, Prentice-Hall, 1999.
2. A.Iserles, A first course in the Numerical Analysis of Differential Equations, Cambridge text in Applied Mathematics.
3. M.K. Jain, S.R.K.I. Yengar, R.K. Jain, Numerical methods for scientific and Engineering computations, New Age International (P), Ltd., 1999.
4. W. Bohem and H. Prautzsch, Numerical Methods, A K Peters, Ltd., 1993.
5. Gilbert Strang, *Linear Algebra and Its Applications (4th Ed.)*, Wellesley Cambridge Press (2009).

6. Philips, G. M.,Taylor, P. J. ; Theory and Applications of Numerical Analysis (2nd Ed.), Academic Press, 1996
7. Gourdin, A. and M Boumhrat; Applied Numerical Methods. Prentice Hall India, New Delhi, (2000)
Gupta, S. K.; Numerical Methods for Engineers. Wiley Eastern, New Delhi, 1995.

2.1.4 NAOE 6201: Sea Keeping Performance

Credit Hour: Three (3.0)
Contact: Hour: Three (3.0) per week

Rationale:

Ship motions because of different types of sea conditions, identifying the aspects of ship construction that contribute to sea keeping performance.

Course Content:

Introduction: Sea-keeping theories, added resistance due to ship motion in regular and irregular waves, added resistance due to wave reflection; Methods of predicting added resistance in waves. Added resistance due to wind; Methods of predicting added resistance due to wind, Resistance increase due to steering on straight course, Sea spectra, Response spectra Sea keeping considerations in design, Involuntary speed loss and power increase at constant power and constant speed approach, Voluntary speed reduction in seaways.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Ability to predict ship motions in seaways
LO-2	Ability to predict added power in seaways
LO-3	Ability to design ship with seakeeping considerations and solve critical design problem

Assessment Strategy:

Continuous Assessment (40 Marks)

Bloom's Category Marks	Class Test/ Quiz (10)	Term Paper/Assignment (5)	Mid Term (15)	Remarks
Remember	✓			10 Marks is allocated for Attendance & Participation
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Semester Final Examination (60 Marks)

Bloom's Category	Test
Remember	5
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	10

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1	Class Test/Quiz	5%	
LO 1-2	Assignment, Term Paper, Class Test, Mid Term	25%	
LO 1-3	Attendance, Class Participation & Final Exam	70%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓										
LO 2	✓										
LO 3	✓			✓					✓		

Reference Book:

1. Dynamics of Marine Vehicles by Rameswar Bhattacharyya
2. Stability and Seakeeping of Marine Vessels by Ermina Begovic and Simone Mancini, Eds.
3. Seakeeping: Ship Behaviour in Rough by Adrian R.J.M. Lloyd
4. Behavior and Handling of Ships by Henry H. Hooyer

2.2 Development Courses

2.2.1 NAOE 6101: Research Methodology

Credit Hour: Three (3.0)
Contact: Hour: Three (3.0) per week

Rationale:

Carrying out the research and writing report involves many steps and requires some skills. The aim of this course is to provide a comprehensive guide for conducting research and writing report including ethical issues and thesis defense.

Course Content:

Concept of Research: Introduction, Field of Research, Broad Classification of Research, Research Skills, Research Variables, Phases of Research and Steps in Conducting Research.
Steps of Carrying out Academic Research: Selection of Topics, Selection of Title, Thesis Proposal, Draft Report, Thesis Defense and Final Report.
Concept of Thesis: Purposes, Characteristics, General Content and General Format.
Research Ethics: Authorship, Plagiarism, Peer Review, Conflict of Interest, Data Management and Research Misconduct.
Research Report Writing Technique: Introduction, Research Question & Hypothesis; Literature Review, Methodology of the Study, Findings, Discussion & Analysis; Conclusion & Recommendations.
Sampling Technique: Introduction, Probabilistic Sampling, Non-probabilistic Sampling, Useful Concept, and Calculation of Sample Size.
Statistical Analysis: Descriptive Statistics (Frequency Distribution, Measure of Central Tendency and Measure of Dispersion) and Inferential Statistics (Hypothesis Testing, Regression Analysis, Analysis of ANOVA and Relevant Test).
Common Tools for Statistical Analysis: Excel Spread Sheet, Microsoft Access and SPSS.
Written Report: Thesis Proposal, Draft Report and Final Report.

Front and Back Matters: Preliminary Pages and Supplementary Documents.
Citation and Referencing Style: Modern Language Association (MLA), American Psychological Association (APA), Chicago Manual of Styles (CMS), IEEE and Oxford Style of Citation.
Thesis Defence: Introduction, Presentation and Oral Examination.
Use of English: Use of Ellipses, Use of Brackets, British and American Spelling.
Check off List: Content, Preliminary Pages, Main Body, Supplementary Documents, Methodology, and Bibliography. Grammar & Spelling, Clarity, Logical Flow, Consistency and Timeline.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Design, implement, and complete research works
LO-2	Write thesis proposal
LO-3	Write thesis report considering ethical issues
LO-4	Defend their thesis

Assessment Strategy:

Continuous Assessment (40 Marks)

Bloom's Category Marks	Class Test/ Quiz (10)	Term Paper/Assignment (5)	Mid Term (15)	Remarks
Remember	✓			10 Marks is allocated for Attendance & Participation
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Semester Final Examination (60 Marks)

Bloom's Category	Test
Remember	5
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	10

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1-2	Class Test & Assignment	10%	
LO 1-3	Term Paper	20%	
LO 1-4	Attendance, Class Participation, Final Exam	70%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓										
LO 2		✓									
LO 3			✓				✓	✓			
LO 4										✓	

Reference Book:

1. S. I.Okoduwa, "The Fundamentals of Scientific Research Paper," 2016. doi: 10.13140/RG.2.2.28131.76323.
2. C. R. Kothari, Research Methodology. New Age International Publishers, 2004.
3. O. D. Apuke, "Quantitative Research Methods A Synopsis Approach"
4. Granziol, "How to Write A master's Thesis: A Guide To Planning Your Thesis, Pursuing It, And Avoiding Pitfalls."
5. Kabir, Basic Guidelines for Research: An Introductory Approach for All Disciplines. Book Zone Publication, Chittagong-4203, Bangladesh, 2017.
6. A-Z D. Deb, R. Dey, and V. E. Balas, Engineering Research Methodology. A Practical Insight for Researchers, vol. 153. 2019.
7. T. K. Kim, "Understanding one-way ANOVA using conceptual figures," Korean J. Anesthesiol., vol. 702017.
8. Alamgir MZ (compiled), "Research Report Writing Technique A-Z." BSMRMU Project, 2023

2.2.2 NAOE 6103: Student's concluding Seminar

Credit Hour: One (1.0)
Contact: Hour: One (1.0) per week

Rationale:

Present day soft skill plays vital role is shaping one's career. Writing and presentation skill are two important soft skills. This course has been designed to enhance these two skills as well as to provide first knowledge on how to conduct a seminar.

Course Content:

Basic Concept of Seminar, Purposes & Objectives of Seminar, Workshop & Seminar, Types of Seminars, Steps of the Seminar, Actors in the Seminar, Purpose of Seminar Paper, Concept of Seminar Paper, Use of Seminar Paper, Steps in writing Seminar Paper, General Format of Seminar Paper. Importance of Presentation, Steps of Presentation, Tips for Presenter, Visual Aid, Handling Questioned Presentation Assessment Criteria.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Write a Seminar Paper
LO-2	Present the Paper effectively
LO-3	Handle the Questions efficiently
LO-4	Deliver speech in a big platform

Assessment Strategy:

Assessment (100 Marks)

Bloom's Category Marks	Attendance (10)	Submission of paper (30)	Presentation (40)	Handling Questionnaire (20)
Remember	✓			
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate				✓
Create		✓		✓

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1-2	Class Test, Assignment	10%	
LO 1-3	Term Paper, Presentation, Mid Term	20%	
LO 1-4	Attendance, Class Participation & Final Exam	70%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓	✓				✓			✓		✓
LO 2					✓					✓	
LO 3										✓	
LO 4										✓	

Reference Book:

1. Jerome A. Pueblos, "How to Conduct a Seminar."
2. Lawrence S Munson, "How to conduct a Training Seminar: A Complete Guide."
3. Abhi Sharma, "Preparing and Presenting a Seminar - A Guide."

2.3 Optional Courses

2.3.1 NAOE 6203: Offshore Renewable Energy

Credit Hour: Three (3.0)
Contact: Hour: Three (3.0) per week

Rationale:

This course will facilitate the students to achieve a clear conceptual understanding of technical and commercial aspects of Wind and Alternative Sources of Energy.

Course Content:

Renewable ocean energy. Wave energy conversion, storage, and performance. Marine current conversion: tidal resource, tidal devices, and practical resource. Tidal phasing. Ocean thermal energy conversion (OTEC) systems: applicability, thermodynamics, design challenges. Wave energy converters, floating devices, oscillating water column, optimal hydrodynamic performance, and current, tidal and offshore wind power. Offshore wind energy: turbine types, fundamentals of operations, installation and maintenance, logistics and decommissioning, environmental impact, electrical systems for renewable energy. Renewable energy integration to grid.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Conceptual knowledge of the technology, economics and regulation related issues associated with wind and alternative sources of energy.
LO-2	Ability to analyse the viability of wind and alternative energy projects.
LO-3	Capability to integrate various options and assess the business and policy environment regarding wind and alternative energy projects.
LO-4	Advocacy of strategic and policy recommendations on usage of wind and alternative energy

Assessment Strategy:

Continuous Assessment (40 Marks)

Bloom's Category Marks	Class Test/ Quiz (10)	Term Paper/Assignment (5)	Mid Term (15)	Remarks
Remember	✓			10 Marks is allocated for Attendance & Participation
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Semester Final Examination (60 Marks)

Bloom's Category	Test
Remember	5
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	10

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1-2	Class Test and Assignment	10%	
LO 1-3	Term Paper, Presentation & Mid Term	20%	
LO 1-4	Attendance, Class Participation, Final Exam	70%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓					✓					
LO 2											
LO 3						✓	✓		✓		
LO 4								✓			

Reference Book:

1. Fundamentals of Ocean Renewable Energy by Simon Neill and M Reza Hashemi.
2. Any relevant book/Journal paper/Article/Thesis paper as appropriate and selected by course teacher.

2.3.2 NAOE 6205: Turbulence Modeling

Credit Hour: Three (3.0)
Contact: Hour: Three (3.0) per week

Rationale:

Sound background in the mathematics and physics of turbulence and to introduce the concepts and tools needed in using and developing turbulence models and turbulence simulation methods.

Course Content:

Introduction to turbulent flows: Governing equations for turbulent flows; Decomposition and averaging of instantaneous quantities; Velocity correlations. Reynolds-averaged Naiver-Stokes (RANS) equations, turbulent kinetic energy equation, Dissipation rate equation. Scalar transport equation: zero equation models: Algebraic models: eddy viscosity and mixing length hypothesis; Cebeci-Smith and Baldwin-Lomax models, one- and two equation models; low-Reynolds number effects, effects of compressibility; Reynolds stress transport equations; Second order closure models; Reynolds-stress and algebraic stress models: Introduction to large-eddy Simulations (LES). Detached-eddy simulations (DES) and direct numerical simulation (DNS).

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Ability to provide a thorough knowledge of turbulence modeling in CFD.
LO-2	Ability to understand the basic principles behind the transport of momentum, energy, and vorticity in turbulent flows
LO-3	Ability to understand the accuracy and reliability of CFD turbulent simulations, as well as discretization techniques, solution strategies, and best standard practices when conducting CFD simulations
LO-4	Ability to assess critically the influence of turbulence models on the outcome of CFD simulations, independently of the software used
LO-5	To appraise results from commercial computational fluid dynamics packages

Assessment Strategy:

Continuous Assessment (40 Marks)

Bloom's Category Marks	Class Test/ Quiz (10)	Term Paper/Assignment (5)	Mid Term (15)	Remarks
Remember	✓			10 Marks is allocated for Attendance & Participation
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Semester Final Examination (60 Marks)

Bloom's Category	Test
Remember	5
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	10

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1-2	Class Test/Quiz	5%	
LO 1-3	Class Test, Assignment, Term Paper	10%	
LO 1-4	Mid Term	15%	
LO 1-5	Attendance, Class Participation & Final Exam	70%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓										
LO 2	✓	✓									
LO 3	✓	✓		✓							✓
LO 4									✓		
LO 5								✓			

Reference Book:

1. D. Wilcox. Turbulence Modeling for CFD. DCW Industries Inc., 2010.
2. Cebeci, T.: Analysis of Turbulent Flows with Computer Programs, Third Edition, Elsevier Ltd., 2013.
3. Davidson, L.: An Introduction to Turbulence Model, Chalmers University of Technology, Goteborg, Sweden, 2016.
4. Hoffmann, K. A. and Chiang, S. T.: Computational Fluid Dynamics, Vol. III, Engineering Education System, Wichita, USA, 2000.

2.3.3 NAOE 6207: Advanced Maritime Economics

- Credit Hour: Three (3.0)
  Contact: Hour: Three (3.0) per week

Rationale:

Advanced Maritime Economics qualifies students to engage in shipping companies' investment decision processes. It combines analytical research approaches and practitioner perspectives and provides students with critical perspectives on investment decision in shipping as well as hands-on business tools to make such decisions.

Course Content:

The economic organization of the shipping market: Economic role of the shipping industry, demand for sea transport, world merchant fleet, supply of sea transport, role of ports in the transport system, Shipping cycles and shipping risk, Characteristics of shipping market cycles, The frequency of shipping cycles, Freight market cycles, 1869–1914, The return on investment in shipping, The prediction of shipping cycles.

Supply, demand and freight rates: The shipping market model, The demand for sea transport, The supply of sea transport, The freight rate mechanism .Costs, revenue and financial performance: Cash flow and the art of survival , The cost of running ships, The capital cost and financial performance , The revenue calculation , Computing the cash flow.

Financing ships and shipping companies: Ship finance and shipping economics, How ships have been financed in the past, The world financial system and types of finance, Financing ships with equity , Financing ships with debt , Finance for new buildings , Leasing ships.

The economic principles of maritime trade: study seaborne trade, The countries that trade by sea, An explanation of trade theory, Theories about the pattern of trade, Economic growth and sea trade, Trade forecasting and the commodity trade model.

The global pattern of maritime trade: Introduction, The Westline theory, Geographical distribution of seaborne trade, Maritime trade of the Atlantic and East Pacific, Maritime trade of the Pacific and Indian Oceans, Eastern Europe, and the former Soviet Union

Bulk cargo and the economics of bulk shipping: The commercial origins of bulk shipping, The bulk trades, The 'transport system' concept, Handling bulk cargoes, Liquid bulk cargoes, The five major dry bulks, The minor bulk trades, Refrigerated cargo, The vehicle trade

The general cargo and the economics of liner shipping: Introduction, The origins of the liner service, Economic principles of liner operation, Liner conferences and their regulation, The components of liner service costs, The liner service cash flow model, Liner prices, The demand for liner services, The liner shipping routes, The liner fleet, The economics of ships and ship designs

The regulatory framework of maritime economics: How maritime regulation affects maritime economics, the institutions that regulate shipping, Self-regulation and the classification societies, The law of the sea, The regulatory role of the flag state,

The economics of shipbuilding and scrapping: Role of the merchant shipbuilding and scrapping industries, Regional structure of world shipbuilding, Shipbuilding market cycles, the economic principles, the shipbuilding production process, shipbuilding costs and competitiveness, the ship breaking industry.

Marketing environment – customer-oriented organization – marketing interface with other functional areas marketing in a globalized environment–The concept of global marketing –Importance, Growth and Benefits-Scope and challenge of international marketing.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Shipping and Shipping Market Economics
LO-2	Shipping Company Economics
LO-3	Seaborne Trade and Transport Systems and maritime business
LO-4	Regulatory frame work of maritime economics
LO-5	Forecasting and Planning, Critical issues of maritime business

Assessment Strategy:

Continuous Assessment (40 Marks)

Bloom's Category Marks	Class Test/ Quiz (10)	Term Paper/Assignment (5)	Mid Term (15)	Remarks
Remember	✓			10 Marks is allocated for Attendance & Participation
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Semester Final Examination (60 Marks)

Bloom's Category	Test
Remember	5
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	10

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1-2	Class Test & Quiz	5%	
LO 1-3	Class Test, Assignment/ Term paper	10%	
LO 1-4	Mid Term	15%	
LO 1-5	Attendance/Class Participation/Final Exam	70%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓		✓								
LO 2	✓										
LO 3	✓		✓				✓				
LO 4	✓										
LO 5	✓				✓		✓		✓		

Reference Book:

1. Maritime Economics by Martin Stopford, Published by Routledge
2. Shipping and Logistics Management by Yuen Ha (Venus) Lun, Kee Hung Lai, Tai Chiu Edwin Cheng, Springer, London, 2010.
3. Acciaro, M. (2014). Real option analysis for environmental compliance: LNG and emission control areas. *Transportation Research Part D: Transport and Environment*, 28, 41-50
4. Albertijn, S., Drobetz, W. and John, M. (2016). Maritime investment appraisal and budgeting, in Kavussanos, M.G. and Visvikis, I.D., *The International Handbook of Shipping Finance*, Palgrave Macmillan, London: 285-313.
5. Geels, F.W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study, *Research Policy*, 31(8), 1257-1274.
6. Gkochari, C.C. (2015). Optimal investment timing in the dry bulk shipping sector, *Transportation Research Part E: Logistics and Transportation Review*, 79: 102-109,
7. Jiang, L., Kronbak, J., & Christensen, L. P. (2014). The costs and benefits of sulphur reduction measures: Sulphur scrubbers versus marine gas oil. *Transportation Research Part D: Transport and Environment*, 28, 19-27.

2.3.4 NAOE 6209: Marine Pollution

Credit Hour: Three (3.0)
Contact: Hour: Three (3.0) per week

Rationale:

Green House Gas (GHG) emission is one of the prime concerns of the world at present. Knowledge of reduction of GHG from ships and floating structure is very important and these are directly linked to several Sustainable Development Goals. In addition, prevention of water pollution from shipping is the requirement of several international law and policy.

Course Content:

Pollutions from Ship: Classification of pollutants- environmental impacts, Pollution risks from ships -air pollution; Heavy metals hazardous Wastes- Solid waste pollution: classification and disposal of solid wastes and liquid sewage- sewage treatment: Primary, Secondary and Tertiary treatment processes.

Ballast Water and Other Marine Pollutants: Environmental threats from ballast water International maritime dangerous goods (IMDG)-Dumping of ship wastes and other materials-Bilge water / waste oil operational management- ballast water treatment- ship breaking and associated issues and ship recycling-Waste management operations.

Environmental Management Systems: Environmental management function-Monitoring Ocean environmental effects-Ocean environmental management process-role of international, national and local

authorities: IMO, MEPC, MARPOL-Managing ocean pollution by ships; Reducing GHG emission from ship at design and operational stage, Energy Efficient Design Index (EEDI)-Energy Efficient Operational Indicator (EEOI), Energy Efficiency Existing Ship Index (EEXI), Ship Energy Efficiency Management Plan (SEEMP), Carbon Dioxide Intensity Indicator (CII), Importance of Improving Energy Efficiency for Inland Ships;

Different Conventions, Laws and Agreement on the prevention of Marine Pollution: accident investigation and surveys- International Oil Pollution Compensation (IOPC) Funds-United Nations Convention on Law of Sea (UNLOS)-Small Tanker Oil Pollution Indemnification Agreement (STOPIA)-Tanker Oil Pollution Indemnification Agreement (TOPIA).

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Understand various types of marine pollution
LO-2	Explain marine pollution mitigation measures.
LO-3	Apply safe design consideration for ships.
LO-4	Understand impact of pollution risk from ships and its presention
LO-5	Describe Environment Management System

Assessment Strategy:

Continuous Assessment (40 Marks)

Bloom's Category Marks	Class Test/ Quiz (10)	Term Paper/Assignment (5)	Mid Term (15)	Remarks
Remember	✓			10 Marks is allocated for Attendance & Participation
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Semester Final Examination (60 Marks)

Bloom's Category	Test
Remember	5
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	10

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1-2	Class Test/ Quiz	5%	
LO 1-3	Class Test, Assignment/ Term paper	10%	
LO 1-4	Mid Term	15%	
LO 1-5	Attendance/Class Participation/Final Exam	70%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓					✓					
LO 2	✓					✓					
LO 3	✓			✓					✓		
LO 4	✓					✓					
LO 5	✓					✓					

Reference Book:

1. Marine Pollution, Shipping Waste and International Law By Gabriela Argüello.
2. Prevention of Pollution of the Marine Environment from Vessels, the Potential and Limits of the International Maritime Organization by Md Saiful Karim.
3. Air Pollution and Ship Emissions by Jacob Boutin.
4. Any relevant book/Journal paper/Article/Thesis paper as appropriate and selected by course teacher.

2.3.5 NAOE 6211: Vibrations and Noises in Marine Structures

Credit Hour: Three (3.0)
Contact: Hour: Three (3.0) per week

Rationale:

To understand the concepts of noise & vibration, approach method, analysis steps, design against noise & vibration on Marine Structures

Course Content:

Overview of marine vibrations and noise: Sources of vibration and noise in marine structures, Human and environmental impacts of vibration and noise, Single degree and multi-degree of freedom systems, Free and forced vibrations, Damping and resonance, Structural Dynamics and Modal Analysis. Modeling of marine structures: Natural frequencies and modes of vibration, Modal analysis techniques, Hydrodynamic Loads and Responses. Approximate numerical methods. Structural Acoustics: Acoustic wave propagation, Sound generation and radiation from marine structures, Acoustic properties of material; Noise Control in Marine Structures; Passive and active noise control measures, Sound insulation and absorption, Noise reduction techniques for machinery, Vibration Control in Marine Structures; Vibration isolation and dampening, Structural modifications and retrofits, Active vibration control techniques, Measurement and Monitoring: Instrumentation and sensors, Data acquisition and analysis, Monitoring and diagnostics. Case Studies.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Free and forced vibrations in one degree of freedom.
LO-2	Response of linear dynamical systems under harmonic excitation.
LO-3	The effect of damping in ship vibrations, Ship Hull-girder, shaft, propeller and engine vibrations in ships.
LO-4	The methodology of using FEA methods for assessing the ship vibrations is also explained. By successful completion of the module
LO-5	Calculate typical vibration problems and have a deep insight in the vibrations experienced by the ship structures;
LO-6	How to search and analyse data to compose solutions required for decision making and develop their critical thinking.

Assessment Strategy:

Continuous Assessment (40 Marks)

Bloom's Category Marks	Class Test/ Quiz (10)	Term Paper/Assignment (5)	Mid Term (15)	Remarks
Remember	✓			10 Marks is allocated for Attendance & Participation
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Semester Final Examination (60 Marks)

Bloom's Category	Test
Remember	5
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	10

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1-2	Class Test	5%	
LO 1-3	Class Test/ Quiz	5%	
LO 1-4	Assignment/ Term paper	5%	
LO 1-5	Mid Term	15%	
LO 1-6	Attendance/Class Participation/Final Exam	70%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓										
LO 2	✓										
LO 3	✓										
LO 4	✓			✓							
LO 5	✓					✓					
LO 6	✓		✓								✓

Reference Book:

1. Theory of Vibration with Applications, Unwin Hyman LTD by Thomson, W.T.
2. Elements of Vibration Analysis, McGraw-Hill, by Meirovitch, L.
3. Vibration of ship structures and its control. VDM Publishing House, Germany, by Lin, Tian Ran.
4. Dynamics of Structures, 5th Edition, University of California at Berkeley, Prentice Hall, by Anil K. Chopra.
5. Structural Vibration: Analysis and Damping, by Beards C.F.

2.3.6 NAOE 6213: Composite materials for marine application

Credit Hour: Three (3.0)
Contact: Hour: Three (3.0) per week

Rationale:

Introduction to atmospheric and submerged marine corrosion; corrosion prevention methods; cathodic protection; fracture and fracture control in marine environments; materials and devices for energy storage, primary/secondary batteries, fuel cells; and composite materials for marine applications.

Course Content:

Basic concepts. Constituent materials for composites. Elements of mechanical behavior of composites. Micromechanics. Strength of a continuous and discontinuous fiber-reinforced lamina. Maximum stress criteria, Maximum Strain Criteria, Analysis of Laminates. Nanocomposite. Finite element analysis of composite structures, Marine composites, Elements of boat scantling system.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Basics of corrosion and the marine environment influence on corrosion.
LO-2	Common classes and properties of marine materials.
LO-3	Elementary materials selection for ocean engineering applications.
LO-4	Basic design for corrosion control.
LO-5	Fracture and failure analysis

Assessment Strategy:

Continuous Assessment (40 Marks)

Bloom's Category Marks	Class Test/ Quiz (10)	Term Paper/Assignment (5)	Mid Term (15)	Remarks
Remember	✓			10 Marks is allocated for Attendance & Participation
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Semester Final Examination (60 Marks)

Bloom's Category	Test
Remember	5
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	10

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1-2	Class Test/ Quiz	5%	
LO 1-3	Class Tests/ Assignment/ Term paper	10%	
LO 1-4	Mid Term	15%	
LO 1-5	Attendance/Class Participation/Final Exam	70%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓					✓					
LO 2	✓										
LO 3	✓	✓									
LO 4	✓			✓							
LO 5	✓								✓		

Reference Book:

1. Composite materials for maritime structures by R. A. Shenoi and J. F. Wellicome, Vol. 1 and Vol. 2, Cambridge University Press.
2. Principles of composite materials mechanics by Ronald D. Gibson
3. Finite element analysis of composite materials using ABAQUS by Ever J. Barbero.
4. Marine Composite-Design and performance by Richard et. al.
5. The elements of boat

2.3.7 NAOE 6215: Hydrodynamic Loading of Marine Structures

Credit Hour: Three (3.0)
Contact: Hour: Three (3.0) per week

Rationale:

In depth understanding of engineering fundamentals to calculate the environmental loads acting on ships and offshore-structures and to gain the understanding of the ships and offshore-structures hydrodynamic design is required for NAOE graduates.

Course Content:

Overview of fluid mechanics, Linear wave theory, Morrison equation and diffraction theory, Numerical solution of green function and fluid forces on floating bodies, Governing equation of second order wave drift forces, Wind and current forces and their effects on floating bodies, Response of floating bodies to regular and irregular waves.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	To be able to identify critical environmental and operational conditions for standard ships and offshore structures

LO-2	To be able to estimate relevant response variables (motions, relative motions, accelerations, etc.) within linear theory and assess safety and operational limit criteria for the specific marine unit.
LO-3	To understand how to estimate second-order effects in the loads, i.e. mean, difference-frequency and sum-frequency effects caused by wave-body interactions and to know the limit of applicability of the approximated approaches. To learn how to estimate added-resistance in waves and to know the major sources of slow-drift damping.
LO-4	To be able to estimate the slowly-varying loads connected with wind gust, the mean and oscillatory loads connected with current (and wind), the effect of wake interactions using a simplified wake solution.
LO-5	To be able to roughly assess occurrence of water on deck and slamming and to know the physical phenomena and factors connected with slamming, its relevance and consequences.

Assessment Strategy:

Continuous Assessment (40 Marks)

Bloom's Category Marks	Class Test/ Quiz (10)	Term Paper/Assignment (5)	Mid Term (15)	Remarks
Remember	✓			10 Marks is allocated for Attendance & Participation
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Semester Final Examination (60 Marks)

Bloom's Category	Test
Remember	5
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	10

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1-2	Class Test/ Quiz	5%	
LO 1-3	Class Tests/ Assignment/ Term paper	10%	
LO 1-4	Mid Term	15%	
LO 1-5	Attendance/Class Participation/Final Exam	70%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓					✓					
LO 2	✓			✓							
LO 3	✓			✓							
LO 4	✓			✓							
LO 5	✓			✓							

Reference Book:

1. Offshore Hydrodynamics by J M J Journcee and W W Massie
2. Dynamics of Fixed Marine Structures, by N. D. P. Barltrop, A. J. Adams
3. Offshore Structure Hydrodynamics by Bernard Molin

2.3.8 NAOE 6217: Finite Element Method for Marine Structures

Credit Hour: Three (3.0)
Contact: Hour: Three (3.0) per week

Rationale:

Fundamental concepts of fatigue damage and failure in engineering structures and contemporary design and analysis procedures is required for NAOE graduates. Finite Element Method is one of the most useful methods to analyze different types of structure.

Course Content:

Introduction to FEM. Variational methods. Element types and properties. Boundary conditions. Stress-strain determination. Solution techniques. Mesh refinement. Convergence criterion. Frames, beams and axial element. Plane stress. Plane strain. Axisymmetric problems. Plate bending. Influence co-efficient and stiffness matrices. Formulation and calculation of the finite element matrices using the principles of virtual displacements. Preparing computer programs. Introduction to the isoperimetric family of elements. Familiarization with and use of existing finite element programs developed for marine structural analysis and design like ships, offshore structures. Pre- and postprocessors for data processing.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Ability to understand the importance of finite element method
LO-2	Ability to formulate and analyze bar, truss, beam, and frame problems.
LO-3	Ability to formulate and calculate the finite element matrices using virtual displacement method
LO-4	Ability to develop codes in MATLAB /Fortran/C++/Python/ Others computer program for analysis using the finite element method.
LO-5	Ability to perform structural analysis of marine structure using finite element software.

Assessment Strategy:

Continuous Assessment (40 Marks)

Bloom's Category Marks	Class Test/ Quiz (10)	Term Paper/Assignment (5)	Mid Term (15)	Remarks
Remember	✓			10 Marks is allocated for Attendance & Participation
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Semester Final Examination (60 Marks)

Bloom's Category	Test
Remember	5
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	10

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1-2	Class Test/ Quiz	5%	
LO 1-3	Class Tests/ Assignment/ Term paper	10%	
LO 1-4	Mid Term	15%	
LO 1-5	Attendance/Class Participation/Final Exam	70%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓										
LO 2	✓	✓									
LO 3	✓	✓									
LO 4	✓			✓							
LO 5	✓			✓							

Reference Book:

1. Introduction to Finite Elements in Engineering, T. R. Chandrupatla,A. D. Belegundu
2. A First Course in the Finite Element Method" by Daryl L. Logan
3. Finite Element Procedures by Klaus-Jurgen Bathe (MIT), Prentice Hall
4. Advanced Marine Structures, Srinivasan Chandrasekaran
5. Programing Language like MATLAB, FORTRAN, C++, Python tutorial etc.

2.3.9 NAOE 6219: Analysis and Design of Welded Structures

Credit Hour: Three (3.0)
Contact: Hour: Three (3.0) per week

Rationale:

In the field of structural analysis, the knowledge and analysis of different types of welded joints needs to be known. Clear concept on the strength requirement and strength from the types of welding is mandatory knowledge for MANOE graduates.

Course Content:

Fatigue design of welded structures: Nominal stress method, Hot spot (geometric/structural) stress method, Effective notch stress method and Applied linear elastic fracture mechanics (LEFM); Influence of different factors that affect the fatigue life and breakdown : stress concentrations, weld defects, welding residual stresses, multiaxial stress states, etc. ; Different post weld improvement techniques ;Weld class systems; Design codes, guidelines for welded joints ; Evaluation and fatigue design of welded structures using FEM: boundary conditions, accuracy, non-linearity, sub-modelling techniques, 3D effects. Different state-of-the art fracture mechanical softwares for prediction of the fatigue life of welded joints.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Choose method for fatigue life assessment with reasonable accuracy for different types of welded joints and structures.
LO-2	Understand the effects of welding residual stress on the structural integrity.
LO-3	Understand the influence of different types of weld defects and discontinuities on the fatigue strength of welded joints.
LO-4	Choose appropriate analysis method and perform fatigue life assessment of complex welded structures.
LO-5	Choose relevant post weld improvement techniques for different welded applications.
LO-6	Use weld quality systems.

Assessment Strategy

Continuous Assessment (40 Marks)

Bloom's Category Marks	Class Test/ Quiz (10)	Term Paper/Assignment (5)	Mid Term (15)	Remarks
Remember	✓			10 Marks is allocated for Attendance & Participation
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Semester Final Examination (60 Marks)

Bloom's Category	Test
Remember	5
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	10

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1-2	Class Test	5%	
LO 1-3	Class Test/ Quiz	5%	
LO 1-4	Class Tests/ Assignment/ Term paper	5%	
LO 1-5	Mid Term	15%	
LO 1-6	Attendance/Class Participation/Final Exam	70%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓	✓									
LO 2	✓	✓									
LO 3	✓					✓					
LO 4	✓			✓					✓		
LO 5	✓	✓									
LO 6	✓										

Reference Book:

1. Timoshenko, S.P.& Woinowsky-Krieger, S. Theory of plates and shells. McGraw Hill, New York.
2. Timoshenko, S.P. & Gere,J.M. Theory of elastic stability. New York-Toronto-London, McGraw Hill
3. T.R. Gurney, Fatigue Welded Structures, Cambridge University Press.
4. Dieter Radaj, Design and Analysis of Fatigue Resistant Welded Structure, Abington Publishing, Cambridge, England
5. S J Maddox, Fatigue Strength of Welded Structures, Woodhead Publishing Series in Welding and other joining technologies.
6. Omer W. Blodgett, Design of Welded Structures
7. Utpal K. Ghosh, Design of Welded Steel Structures, CRC press.
8. J.F. Lancaster, Handbook of Structural Welding: Processes, Materials and Methods Used in the Welding of Major Structures, Pipelines and Process Plant, Woodhead Publishing Series in Welding and other joining technologies.

2.3.10 NAOE 6221: Advanced Marine Engineering

Credit Hour: Three (3.0)
Contact: Hour: Three (3.0) per week

Rationale:

In depth knowledge on the theory based on application and understanding of various marine machineries and their mechanism is mandatory for MANOE degree.

Course Content:

Analysis of various marine power plant and selection criteria for choosing, Special and latest propulsion theory, Selection criteria and procedure of main machinery and auxiliaries, Control and monitoring systems, Design of marine shafting, transmission, Clutch design and operation, Friction, lubrication and cooling, Hydraulic and pneumatic system.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Study and analyze the power plant to fulfill the requirement
LO-2	Evaluate the various types of propulsion machinery
LO-3	Analyze the shafting and transmission system
LO-4	Study on wear characteristics

Assessment Strategy:

Continuous Assessment (40 Marks)

Bloom's Category Marks	Class Test/ Quiz (10)	Term Paper/Assignment (5)	Mid Term (15)	Remarks
Remember	✓			10 Marks is allocated for Attendance & Participation
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Semester Final Examination (60 Marks)

Bloom's Category	Test
Remember	5
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	10

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1-2	Class Test/ Quiz	10%	
LO 1-3	Assignment/ Term paper/ Mid Term	20%	
LO 1-4	Attendance/Class Participation/Final Exam	70%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓			✓					✓		
LO 2	✓							✓			
LO 3	✓			✓							
LO 4	✓	✓									

Reference Book:

1. Advanced Marine Engineering Knowledge- V. Gokhale and N. Nanda
2. Motor Engineering Knowledge for Marine Engineers- T D Morton and L Jackson

3. General Engineering Knowledge for Marine Engineers- P A Russle, T D Morton and L Jackson
4. Tribology- B Bhusan
5. Open sources

2.3.11 NAOE 6223: High Speed Marine Vehicles

Credit Hour: Three (3.0)
Contact: Hour: Three (3.0) per week

Rationale:

Theoretical course to develop specialization in the creative design and engineering of high-performance commercial vehicles, including power yachts, fast ferries, hydrofoils, hover craft, fishing boats, etc.

Course Content:

Introduction to high-speed vehicles; Types, general characteristics, hull form and geometry of semi-planning hull, planning hull, hydrofoil vessels and surface effect ships (SES); Important design parameters; Hydrodynamics design aspects; Resistance; Power prediction; Propulsion systems and Stability evaluation.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Discuss about different types of high-speed vehicles, their typical applications, and their hydrodynamic features.
LO-2	Interpret theoretical and experimental investigations of hydrodynamic properties applied I design of high-speed marine vehicles.
LO-3	Analyze and calculate hydrodynamic properties of high-speed marine vehicles.
LO-4	Explain the concepts and terminology of high speed marine vehicles

Assessment Strategy:

Continuous Assessment (40 Marks)

Bloom's Category Marks	Class Test/ Quiz (10)	Term Paper/Assignment (5)	Mid Term (15)	Remarks
Remember	✓			10 Marks is allocated for Attendance & Participation
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Semester Final Examination (60 Marks)

Bloom's Category	Test
Remember	5
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	10

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1-2	Class Test/ Quiz	10%	
LO 1-3	Assignment/ Term paper/ Mid Term	20%	
LO 1-4	Attendance/Class Participation/Final Exam	70%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓										
LO 2	✓			✓							
LO 3	✓			✓							
LO 4	✓										

Reference Book:

1. Odd M. Faltinsen, Hydrodynamics of High-Speed Marine Vehicles, Cambridge University Press
2. J.D. Anderson, Fundamentals of Aerodynamics, McGraw-Hill Book Company, New York
3. Liang Yun and Alan Bliault, High Performance Marine Vessels, Springer Publication, 2012

2.3.12 NAOE 6225: Offshore Drilling and Subsea Engineering

Credit Hour: Three (3.0)
Contact: Hour: Three (3.0) per week

Rationale:

In-depth overview of all subsea system components, including detailed procedures for maintenance of all major well control equipment components, understanding of typical standing procedures, and currents standards, rules and regulations.

Course Content:

Introduction: Offshore drilling and production overview, Environmental and safety considerations; Geology and Geophysics: Rock and fluid properties, Reservoir modeling and simulation; Drilling Engineering: Rig types and components, Drilling fluids and their properties, Drilling operations and procedures, Casing and cementing; Well Completion and Intervention: Types of completions and their applications, Intervention techniques and tools, Wellhead systems; Subsea Systems and Components: Subsea trees and manifolds, Subsea control systems, Subsea umbilical's, risers, and flow lines (SURF); Subsea Production Systems: Subsea processing and separation, Subsea boosting and compression, Multiphase flow and metering; Subsea Pipeline Engineering: Pipeline design and materials, Pipeline installation and maintenance, Pipeline inspection and repair; Offshore Safety and Environmental Protection: Risk assessment and management, Safety systems and procedures, Environmental regulations and compliance.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Discuss basic geology and petroleum concepts;
LO-2	Describe the stages of planning and drilling a well and list the tools required for each stage;

LO-3	Recognize the types of drilling units in use today;
LO-4	Indicate the components of a drilling rig and their purposes;
LO-5	Identify the types of drilling fluids and their components;
LO-6	Explain the need for casting and cementing a well, and the methods for doing so;
LO-7	Compare the difference between bottoms founded, anchored and dynamically positioned rigs and their applications;

Assessment Strategy:

Continuous Assessment (40 Marks)

Bloom's Category Marks	Class Test/ Quiz (10)	Term Paper/Assignment (5)	Mid Term (15)	Remarks
Remember	✓			10 Marks is allocated for Attendance & Participation
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Semester Final Examination (60 Marks)

Bloom's Category	Test
Remember	5
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	10

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1-2	Class Test/Quiz	5%	
LO 1-3	Class Test	5%	
LO 1-4	Term Paper/Assignment	5%	
LO 1-5	Attendance/Class Participation	5%	
LO 1-6	Mid Term	15%	
LO 1-7	Attendance/Class Participation & Final Exam	65%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓										
LO 2	✓										
LO 3	✓										
LO 4	✓										
LO 5	✓							✓			
LO 6	✓										
LO 7	✓								✓		

Reference Book:

1. Subsea Pipeline Engineering by Andrew Palmer and Dr. Roger King
2. Subsea Engineering Handbook by Yong Bai and Qiang Bai
3. Fundamentals of Marine Riser Mechanics by Charles Sparks
4. Any relevant course material/book/journal/technical paper as suggested by the course teacher.

2.3.13 NAOE 6227: Artificial Intelligence for Maritime Applications

Credit Hour: Three (3.0)
Contact: Hour: Three (3.0) per week

Rationale:

Identify problems where artificial intelligence techniques are applicable. Apply selected basic AI techniques, judge applicability of more advanced techniques. Participate in the design of systems that act intelligently and learn from experience.

Course Content:

Introduction to variant of machine learning methods and application for ship autonomy, potential use of machine learning methods for solving specific problems on autonomous ships, path planning, auto docking and motion prediction, case studies for each of introduced machine learning methods. Dijkstra method. A* method for path planning for close range maneuvering. Neural network architecture for ship motion prediction and force allocation to thrusters. Deep learning methods for maritime application.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Have a good understanding of Machine Learning (ML) methods and their pros and cons;
LO-2	Have knowledge of challenges in marine applications;
LO-3	Know how to deal with data, formulate the problem, simplify model complicity, and select Artificial Intelligence (AI) methods;
LO-4	Be able to design and implement their own AI algorithms for real applications.

Assessment Strategy:

Continuous Assessment (40 Marks)

Bloom's Category Marks	Class Test/ Quiz (10)	Term Paper/Assignment (5)	Mid Term (15)	Remarks
Remember	✓			10 Marks is allocated for Attendance & Participation
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Semester Final Examination (60 Marks)

Bloom's Category	Test
Remember	5
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	10

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1-2	Class Test & Quiz	10%	
LO 1-3	Term Paper/Assignment/ Mid Term	20%	
LO 1-4	Attendance/Class Participation/ Final Exam	70%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓										✓
LO 2	✓								✓		
LO 3	✓		✓								
LO 4	✓			✓							✓

Reference Book:

1. Understanding machine learning: From theory to algorithms by S. Shalev-Shwartz, and S. Ben-David, Cambrige University Press, 2014.
2. Machine learning for absolute beginners: a plain English introduction by O. Theobaid, Scatterplot Press, 2017.
3. Artificial Intelligence: a modern approach by S. Russel, and P. Norvig, Pearson, 2020.

2.3.14 NAOE 6229: Mooring and Riser Analysis

Credit Hour: Three (3.0)
Contact: Hour: Three (3.0) per week

Rationale:

Offshore structures are mainly floating structures in the sea that are used as oil platform, wind and wave energy harnessing and so on. These structures need to be positioned in stationary conditions in order to have smooth operation and production. Riser and Mooring system provide this supports to those structures. Therefore, learning Mooring and risers and their analysis is required.

Course Content:

Design and installation operations for riser and mooring systems. Design of deep-water moorings and riser system and design codes and criteria. Types and layout of risers, layout and geometry of mooring and line types. Riser and mooring line design cycle, pretension and static equilibrium, and Vortex Induced Vibration (VIV), and analyse of the static and dynamic performances including floaters. Dynamic performances of riser/mooring lines using simulation software (e.g. MOSES, HYDROSTAR, ARIANE and ORCAFLEX) and analyse the fatigue of riser and mooring chains.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Explain different design and operational aspects of riser and mooring systems
LO-2	Requirements of deep-water moorings and riser system
LO-3	Analyze using different types of simulation software.
LO-4	Describe and apply theories and concepts for designing subsea pipelines, riser and mooring system of marine vehicles and floating structures.

Assessment Strategy:

Continuous Assessment (40 Marks)

Bloom's Category Marks	Class Test/ Quiz (10)	Term Paper/Assignment (5)	Mid Term (15)	Remarks
Remember	✓			10 Marks is allocated for Attendance & Participation
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Semester Final Examination (60 Marks)

Bloom's Category	Test
Remember	5
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	10

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1-2	Class Test / Quiz	10%	
LO 1-3	Term Paper/Assignment/ Mid Term	20%	
LO 1-4	Attendance/Class Participation/ Final Exam	70%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓			✓							
LO 2	✓										
LO 3	✓										✓
LO 4	✓			✓					✓		

Reference Book:

1. Dynamics of Deepwater Riser: Theory and Method 1st ed. 2022 Edition by Weiping Huang (Author), Xuemin Wu (Author), Juan Liu (Author), Xinglan Bai (Author)
2. Mooring System Engineering for Offshore Structures by Kai-Tung Ma, Yong Luo, Thomas Kwan, Yongyan Wu
3. GUIDE TO SINGLE POINT MOORINGS by Johan Wichers
4. Any relevant book/Journal paper/Article/Thesis paper as appropriate and selected by course teacher.

2.4 Thesis

2.4.1 NAOE 6000: Thesis

Credit Hour: Eighteen (18.0), divided into 3 semesters.

Rationale:

This course intends to involve the students in carrying out specific research related to naval architecture and offshore engineering discipline. It will help them to learn how to carry out engineering research work, present and defend the research work, and write a thesis paper.

Course Content/research fields:

Major Fields of thesis are as follows: (a) Ship design (b) Ship construction (c) Strength of ship (d) Material testing and fracture problems (e) Ship motion (f) Resistance and propulsion of ships (g) Marine engines and ship vibration (h) Marine transportation system (i) Marine engineering (j) Dynamics of ship/floating bodies/structures (k) Environmental impact assessment (l) Life cycle assessment (LCA). (m) Offshore structure design (n) Subsea pipeline (o) Mooring and Riser design (p) Drilling system etc. and (q) Contemporary maritime issues and challenges.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Understand the difference between high and low-quality journal.
LO-2	Formulation of research question and learn how to find a research question.
LO-3	Learn how to conduct an empirical study: Data analysis must be more rigorous, e.g., has to take a particular approach to analyzing the data, justification for the analysis.

LO-4	Learn how to develop a conceptual thesis: Implications for developing the conceptual argument (what does it change), more sophisticated argument, reflect on limitations and future research
LO-5	Learn how to write an academic text: Coherence in terms of literature review, research question, method, findings.
LO-6	Learn how to develop a contribution: Theorizing, developing a theoretical contribution.

Assessment Strategy:

Assessment (100 Marks)

Bloom's Category Marks	Report Submission (50)	Presentation (30)	Oral Examination (20)	Remarks
Remember	✓			
Understand	✓			
Apply		✓		
Analyze		✓		
Evaluate			✓	
Create		✓	✓	

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1-2	Literature review & Report Submission	5%	
LO 1-3	Data collection & Report Submission	5%	
LO 1-4	Data Analysis & Presentation/Question	10%	
LO 1-5	Findings analysis & Draft report preparation	5%	
LO 1-6	Final Report Submission, Presentation and Oral Exam	75%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1	✓										
LO 2	✓	✓									
LO 3	✓		✓		✓				✓		
LO 4	✓				✓				✓		
LO 5	✓								✓		
LO 6	✓								✓		

Reference Book:

1. Any books/journal papers/thesis/research papers related to individual thesis topic.

2.5 NAOE 6002: Field Trip

Credit Hour: Non Credit Course

Rationale:

To orient students with the practical function of different maritime organizations.

Contents:

Study tour to various industries for example Naval Architectural design firms, Shipyards, Dockyards, Dry-docks, Ports & harbour, dredging operations etc.

Course Learning Outcomes (LO):

On successful completion of this course, students should be able to:

LO-1	Explain the practical functions of maritime organization.
LO-2	Analyse the duties and responsibilities of different maritime professionals

Assessment Strategy:

Assessment (100 Marks)

Bloom's Category Marks	Attendance (20)	Participation (20)	Visit Report (30)	Presentation (30)	Remarks
Remember	✓				
Understand	✓	✓			
Apply			✓	✓	
Analyze			✓		
Evaluate			✓	✓	
Create		✓		✓	

Linkage of LO with Assessment Methods and their weights: Learning Outcome	Assessment Methods	Weightage	Remarks
LO 1	Attendance & Participation	40%	
LO 1-2	Visit report & Presentation	60%	

Mapping of Course LO and Program Outcomes (PLO):

Course Learning Outcomes (LOs) of this course	Program Learning Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
LO 1					✓			✓			
LO 2						✓	✓				