

Kasetsart University
Faculty of International Maritime Studies
Program in Naval Architecture and Ocean Engineering

1. NAME OF CURRICULUM

Bachelor of Engineering Program in Naval Architecture and Ocean Engineering

2. NAME OF DEGREE

Bachelor of Engineering (Naval Architecture and Ocean Engineering)

B.Eng. (Naval Architecture and Ocean Engineering)

3. Curriculum Outline for Naval Architecture and Ocean Engineering Student

Total credit requirements	at least	150	credits
1) General Education Courses	at least	30	credits
1.1) Wellness	at least	6	credits
1.2) Entrepreneurship	at least	3	credits
1.3) Language and Communication	at least	13	credits
1.4) Thai Citizen and Global Citizen	at least	5	credits
1.5) Aesthetics	at least	3	credits
2) Naval Architecture and Marine Engineering Courses at least		114	credits
2.1) Fundamental Courses		30	credits
2.1.1) Mathematics and Science Courses		20	credits
2.1.2) Fundamental Engineering Courses		10	credits
2.2) Specific Courses		84	credits
2.2.1) Compulsory Engineering Courses		75	credits
2.2.2) Engineering Elective Courses		9	credits
3) Free Electives	at least	6	credits
4) Internship and Job Visiting	at least	240	hours
5) Detail of Curriculum			
1. General Education Courses	at least	30	credits
1.1 Wellness	at least	3	credits
Physical Education Activity			1(- -)

* Student has to apply at least 5 credits by choosing other subjects in this category in order to complete minimum credit requirement.

1.2 Entrepreneurship **at least 3 credits**

* Student has to choose subjects in this category to complete minimum credit requirement.

1.3 Language and Communication **at least 13 credits**

01355xxx English 9(- -)

Thai Language 3(- -)

Information Technology/Computer 1(- -)

1.4 Thai Citizen and Global Citizen **at least 5 credits**

01999111 Knowledge of the Land 2(2-0-4)

* Student has to obtain the other 3 credits, at least, by choosing other subjects in this category.

1.5 Aesthetics **at least 3 credits**

* Student has to choose subjects in this category to complete minimum credit requirement.

2. Naval Architecture and Ocean Engineering Courses at least 114 credits

2.1 Fundamental Courses **30 credits**

2.1.1) Basic Mathematics and Science Course **20 credits**

01403114 Laboratory in Fundamental of General Chemistry 1(0-3-2)

01403117 Fundamental of General Chemistry 3(3-0-6)

01417167 Engineering Mathematics I 3(3-0-6)

01417168 Engineering Mathematics II 3(3-0-6)

01417267 Engineering Mathematics III 3(3-0-6)

01420111 General Physics I 3(3-0-6)

01420112 General Physics II 3(3-0-6)

01420113 Laboratory in Physics I 1(0-3-2)

2.1.2) Fundamental Engineering Course **10 credits**

03603101 Introduction to Computer Programming 3(2-3-6)

03604111 Engineering Drawing 3(2-3-6)

03604223 Basic Principles of Engineering Mechanics 3(3-0-6)

03604281 Workshop Practice 1(0-3-2)

2.2) Specified Application Courses **84 credits**

2.2.1) Compulsory engineering Course **75 credits**

03501212 Introduction to Naval Architecture and Ocean Engineering 3(3-0-6)

Ocean Engineering

03501214	Marine Electrical Engineering Laboratory	1(0-3-2)
03501221	Ship Structures I	3(3-0-6)
03501241	Fluid Mechanics in Naval Architecture and Marine Engineering	3(3-0-6)
03501261	Computer-Aided Design and Drafting for Marine Engineering	3(2-2-5)
03501271	Introduction to Marine Electrical Engineering	3(3-0-6)
03501281	Applied Thermodynamics for Marine Engineers	3(3-0-6)
03501311	Maritime Engineering Laboratory I	1(0-3-2)
03501312	Maritime Engineering Laboratory II	1(0-3-2)
03501321	Ship Structures II	3(3-0-6)
03501322	Marine Engineering Material	3(3-0-6)
03501332	Ship Vibrations	3(3-0-6)
03501333	Ship Dynamics	3(3-0-6)
03501334	Ship Hydrostatics and Stability	3(3-0-6)
03501342	Ship Resistance and Propulsion	3(3-0-6)
03501352	Ship Production and Safety in a Shipyard	3(3-0-6)
03501355	Introduction to Maritime Law and Environment	3(3-0-6)
03501363	Marine Mechanical Design	3(3-0-6)
03501446	Marine Engineering	3(3-0-6)
03501459	Shipyard Management	3(3-0-6)
03501461	Ship Design	3(3-0-6)
03501463	Computer-Aided Naval Architecture and Ocean Engineering	3(2-2-5)
03501472	Ship Control Systems	3(3-0-6)
03501473	Digital Technology and Artificial Intelligence in Maritime Engineering	3(3-0-6)
03501481	Heat Transfer and Marine Thermal Energy System	3(3-0-6)
03501482	Marine Refrigerator and Air Conditioner	3(3-0-6)
03604241	Thermodynamics I	3(3-0-6)

2.2.2) Engineering elective Course at least 9 credits

* Student who opts for cooperative program has to choose 6 credits of the following course

03501490	Cooperative Education	6
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and choose to study engineering elective course of not less than 3 credits

* Student who does not opt for cooperative program has to choose at least 3 credits of the following courses

03501495	Naval Architecture and Ocean Engineering Project Preparation	1(0-3-2)
03501499	Naval Architecture and Ocean Engineering Project	2(0-6-3)

and choose to study engineering elective courses of not less than 6 credits

Engineering Elective Course

Structures and Materials

03501421	Ship Structures III	3(3-0-6)
03501423	Marine Corrosion	3(3-0-6)
03501425	Composite Structures	3(3-0-6)

Fluid Dynamics

03501341	Ship Hydrodynamics	3(3-0-6)
03501343	Marine Piping and Pump System	3(3-0-6)
03501443	Hydrofoil and Propeller Design	3(3-0-6)

Renewable Energy, Naval Architect and Offshore Engineering

03501353	Ship Operations and Maintenance	3(3-0-6)
03501452	Offshore Engineering	3(3-0-6)
03501486	Ocean Renewable Energy	3(3-0-6)

Computer-Aided Design and Computing

03501361	Applied Numerical Method for Naval Architecture and Ocean Engineering	3(3-0-6)
03501462	Modern Marine Vehicles Design	3(3-0-6)

Other

03501496	Selected Topics in Naval Architecture and Ocean Engineering	3(3-0-6)
03501498	Special Problems	1-3

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|---------------------------------------|-----------------|------------|----------------|
| 3. Free Electives | at least | 6 | credits |
| 4. Internship and Job Visiting | at least | 240 | hours |

Course Planning for Naval Architecture and Ocean Engineering Students

Non-Cooperative Education Program

First Year

Semester 1

Course Number	Title	Credits (lecture-lab-self study)
01417167	Engineering Mathematics I	3(3-0-6)
01420111	General Physics I	3(3-0-6)
01420113	Laboratory in Physics I	1(0-3-2)
01999111	Knowledge of the Land	2(2-0-4)
03604111	Engineering Drawing	3(2-3-6)
01355xxx	English	3(- -)
	Thai Language	3(- -)
	Information Technology/Computer	<u>1(- -)</u>
	Total	<u>19(- -)</u>

Semester 2

Course Number	Title	Credits (lecture-lab-self study)
01403114	Laboratory in Fundamental of General Chemistry	1(0-3-2)
01403117	Fundamental of General Chemistry	3(3-0-6)
01417168	Engineering Mathematics II	3(3-0-6)
01420112	General Physics II	3(3-0-6)
03603101	Introduction to Computer Programming	3(2-3-6)
	Physical Education Activity	1(- -)
	Wellness	2(- -)
	Thai Citizen and Global Citizen	<u>3(- -)</u>
	Total	<u>19(- -)</u>

Second Year

Semester 1

Course Number	Title	Credits (lecture-lab-self study)
01417267	Engineering Mathematics III	3(3-0-6)
03501212	Introduction to Naval Architecture and Ocean Engineering	3(3-0-6)
03501261	Computer-Aided Design and Drafting for Marine Engineering	3(2-2-5)
03604241	Thermodynamics I	3(3-0-6)
03604223	Basic Principles of Engineering Mechanics	3(3-0-6)
03604281	Workshop Practice	1(0-3-2)
01355xxx	English	<u>3(- -)</u>
	Total	<u>19(- -)</u>

Semester 2

Course Number	Title	Credits (lecture-lab-self study)
03501214	Marine Electrical Engineering Laboratory	1(0-3-2)
03501221	Ship Structures I	3(3-0-6)
03501241	Fluid Mechanics in Naval Architecture and	3(3-0-6)
03501271	Introduction to Marine Electrical Engineering	3(3-0-6)
03501281	Applied Thermodynamics for Marine Engineers	3(3-0-6)
	Entrepreneurship	3(- -)
	Aesthetics	<u>3(- -)</u>
	Total	<u>19(- -)</u>

Third Year

Semester 1

Course Number	Title	Credits (lecture-lab-self study)
03501311	Maritime Engineering Laboratory I	1(0-3-2)
03501321	Ship Structures II	3(3-0-6)
03501322	Marine Engineering Material	3(3-0-6)
03501334	Ship Hydrostatics and Stability	3(3-0-6)
03501355	Introduction to Maritime Law and Environment	3(3-0-6)
01355xxx	English	3(- -)
	Free Electives	<u>3(- -)</u>
	Total	<u>19(- -)</u>

Semester 2

Course Number	Title	Credits (lecture-lab-self study)
03501312	Maritime Engineering Laboratory II	1(0-3-2)
03501332	Ship Vibrations	3(3-0-6)
03501333	Ship Dynamics	3(3-0-6)
03501342	Ship Resistance and Propulsion	3(3-0-6)
03501352	Ship Production and Safety in a Shipyard	3(3-0-6)
03501363	Marine Mechanical Design	3(3-0-6)
	Engineering elective Course	<u>3(- -)</u>
	Total	<u>19(- -)</u>

End of Semester 2 Internship at least 240 hours

Fourth Year

Semester 1

Course Number	Title	Credits (lecture-lab-self study)
03501446	Marine Engineering	3(3-0-6)
03501461	Ship Design	3(3-0-6)
03501463	Computer-Aided Naval Architecture and Ocean Engineering	3(2-2-5)
03501481	Heat Transfer and Marine Thermal Energy System	3(3-0-6)
03501495	Naval Architecture and Ocean Engineering Project Preparation	1(0-3-2)
	Engineering elective Course	3(- -)
	Wellness	<u>3(- -)</u>
	Total	<u>19(- -)</u>

Semester 2

Course Number	Title	Credits (lecture-lab-self study)
03501459	Shipyards Management	3(3-0-6)
03501472	Ship Control Systems	3(3-0-6)
03501473	Digital Technology and Artificial Intelligence in Maritime Engineering	3(3-0-6)
03501482	Marine Refrigerator and Air Conditioner	3(3-0-6)
03501499	Naval Architecture and Ocean Engineering Project	2(0-6-3)
	Free Electives	<u>3(- -)</u>
	Total	<u>17(- -)</u>

Course Planning for Naval Architecture and Ocean Engineering Students

Cooperative Education Program

First Year

Semester 1

Course Number	Title	Credits (lecture-lab-self study)
01417167	Engineering Mathematics I	3(3-0-6)
01420111	General Physics I	3(3-0-6)
01420113	Laboratory in Physics I	1(0-3-2)
01999111	Knowledge of the Land	2(2-0-4)
03604111	Engineering Drawing	3(2-3-6)
01355xxx	English	3(- -)
	Thai Language	3(- -)
	Information Technology/Computer	1(- -)
	Total	<u>19(- -)</u>

Semester 2

Course Number	Title	Credits (lecture-lab-self study)
01403114	Laboratory in Fundamental of General Chemistry	1(0-3-2)
01403117	Fundamental of General Chemistry	3(3-0-6)
01417168	Engineering Mathematics II	3(3-0-6)
01420112	General Physics II	3(3-0-6)
03603101	Introduction to Computer Programming	3(2-3-6)
	Physical Education Activity	1(- -)
	Wellness	2(- -)
	Thai Citizen and Global Citizen	3(- -)
	Total	<u>19(- -)</u>

Second Year

Semester 1

Course Number	Title	Credits (lecture-lab-self study)
01417267	Engineering Mathematics III	3(3-0-6)
03501212	Introduction to Naval Architecture and Ocean Engineering	3(3-0-6)
03501261	Computer-Aided Design and Drafting for Marine Engineering	3(2-2-5)
03604241	Thermodynamics I	3(3-0-6)
03604223	Basic Principles of Engineering Mechanics	3(3-0-6)
03604281	Workshop Practice	1(0-3-2)
01355xxx	English	<u>3(- -)</u>
	Total	<u>19(- -)</u>

Semester 2

Course Number	Title	Credits (lecture-lab-self study)
03501214	Marine Electrical Engineering Laboratory	1(0-3-2)
03501221	Ship Structures I	3(3-0-6)
03501241	Fluid Mechanics in Naval Architecture and	3(3-0-6)
03501271	Introduction to Marine Electrical Engineering	3(3-0-6)
03501281	Applied Thermodynamics for Marine Engineers	3(3-0-6)
	Wellness	3(- -)
	Entrepreneurship	3(- -)
	Aesthetics	<u>3(- -)</u>
	Total	<u>22(- -)</u>

Third Year

Semester 1

Course Number	Title	Credits (lecture-lab-self study)
03501311	Maritime Engineering Laboratory I	1(0-3-2)
03501321	Ship Structures II	3(3-0-6)
03501322	Marine Engineering Material	3(3-0-6)
03501334	Ship Hydrostatics and Stability	3(3-0-6)
03501355	Introduction to Maritime Law and Environment	3(3-0-6)
03501481	Heat Transfer and Marine Thermal Energy System	3(3-0-6)
01355xxx	English	3(- -)
	Free Electives	<u>3(- -)</u>
	Total	<u>22(- -)</u>

Semester 2

Course Number	Title	Credits (lecture-lab-self study)
03501312	Maritime Engineering Laboratory II	1(0-3-2)
03501332	Ship Vibrations	3(3-0-6)
03501333	Ship Dynamics	3(3-0-6)
03501342	Ship Resistance and Propulsion	3(3-0-6)
03501352	Ship Production and Safety in a Shipyard	3(3-0-6)
03501363	Marine Mechanical Design	3(3-0-6)
	Engineering elective Course	3(- -)
	Free Electives	<u>3(- -)</u>
	Total	<u>22(- -)</u>

Fourth Year

Semester 1

Course Number	Title	Credits (lecture-lab-self study)
03501446	Marine Engineering	3(3-0-6)
03501459	Shipyards Management	3(3-0-6)
03501461	Ship Design	3(3-0-6)
03501463	Computer-Aided Naval Architecture and Ocean Engineering	3(2-2-5)
03501472	Ship Control Systems	3(3-0-6)
03501473	Digital Technology and Artificial Intelligence in Maritime Engineering	3(3-0-6)
03501482	Marine Refrigerator and Air Conditioner	<u>3(3-0-6)</u>
	Total	<u>21(20-2-41)</u>

Semester 2

Course Number	Title	Credits (lecture-lab-self study)
03501490	Cooperative Education	<u>6</u>
	Total	<u>6(- -)</u>

COURSE DESCRIPTIONS

- 03501211 Overview in Marine and Ocean Systems 3(3-0-6)
Sea, Ocean and general knowledge on oceanography, mercantile marine, transportation and fishery systems, basic of ship operation, astronomy, meteorology, maritime law; type and classification of marine vehicles, basic concept of marine vehicle and offshore structure design, naval architecture and marine engineering professions, preparation, codes and ethics of and naval architect and marine engineer.
- 03501212 Introduction to Naval Architecture and Ocean Engineering 3(3-0-6)
Types and purposes of ships and floating structures. Fundamental properties of floating bodies. Basic concepts of ship resistance and propulsion. Power system. Strength and dynamic of ships and floating structures. General knowledge on maritime and shipyard industries as well as ocean engineering.
- 03501214 Marine Electrical Engineering Laboratory 1(0-3-2)
Prerequisite : 03501271 or Corequisite
Fundamental experiments on marine electrical engineering, DC circuits, AC circuits, power factor correction, electrical characteristic test for important marine electrical devices and equipment.
- 03501221 Ship Structures I 3(3-0-6)
Prerequisite : 03604223
Concept of forces. Stresses and strain. Hooke's law. Stress and strain under axial loading and shear loading. Torsion. Stresses in a shaft within the elastic range. Pure bending. Shear and bending moment diagrams. Shearing stresses in a beam and thin-walled member. Transformations of stress and strain. Mohr's circle. Stresses under combined loadings.
- 03501241 Fluid Mechanics in Naval Architecture and Marine Engineering 3(3-0-6)
Prerequisite : 01417168
Properties of fluid, hydrostatic, displacement and buoyancy, fresh water allowance, stability and metacenter, bernoulli equation, equation of

continuity and motion, momentum and energy equations, potential flow, similitude and dimensional analysis, pipe flow, drag force and lift force, free surface flow, wave mechanics, steady incompressible flow.

- 03501257 Naval Architecture and Marine Engineering Statistics 3(3-0-6)
Probability theory. Principle of statistic. Random process and irregular wave loads analysis. Wave spectrum load for ships and offshore structures analysis. Statistical analysis in Naval Architecture and Marine Engineering.
- 03501261 Computer-Aided Design and Drafting for Marine Engineering 3(2-2-5)
Prerequisite : 03604111
To use computer and programming to design two dimensional and three dimensional for marine engineering. Create and solve problem in marine engineering which could apply to related work.
- 03501271 Introduction to Marine Electrical Engineering 3(3-0-6)
Prerequisite : 01420112
Type and purpose of general shipboard electrical system, basic concepts of electrical circuits and circuit calculations, vital electrical systems and equipment onboard ship, electrical load analysis of ship.
- 03501281 Applied Thermodynamics for Marine Engineers 3(3-0-6)
Prerequisite : 03604241
Principle of reciprocating engines, compression ignition engines, diesel cycle, applications to reciprocating engines in ships and marine vehicles, principle of gas turbine engines, brayton cycle, applications to gas turbine engines in ships and marine vehicles, refrigeration, vapor compression refrigeration cycle, application to ship refrigeration systems, air conditioning, application to ship air conditioning systems, introduction to ship propulsion and ship auxiliary system.

03501311	Maritime Engineering Laboratory I Prerequisite : 03604241 and 03501221 Dynamic labs. Material and structure tests. Thermodynamics and heat transfer labs. Engine tests..	1(0-3-2)
03501312	Maritime Engineering Laboratory II Prerequisite : 03501241 and 03501334 or 03503321 Experiments on fluid mechanics. Naval architecture and ocean engineering labs. Ship buoyancy and stability labs. Ship model testing. Ship incline experiment. Propeller test.	1(0-3-2)
03501321	Ship Structures II Prerequisite : 03501221 Calculation of forces exerted on ships and offshore structures. Calculation of ship longitudinal strength. Load distributions on ship. Analysis of midship section combined stresses and losses of ship strength. Buckling of stanchions. Failure theory. Strength of hull panels including major parts of ship structures. Ship framing systems. Materials using in ship structures. Corrosion and protection.	3(3-0-6)
03501322	Marine Engineering Material Relationships between structures, properties and production processes. Applications of main groups of marine engineering materials ; metals, polymers, ceramics and composite materials. Phase equilibrium diagrams and their interpretations. Mechanical properties of marine engineering materials. Fabrication techniques of metals for marine use. Heat treatment of steels. Non-ferrous metals for marine use. Corrosion and degradation of marine engineering materials. Selection of stainless steels for marine applications.	3(3-0-6)
03501332	Ship Vibrations Prerequisite : 03604223 Basic mechanical vibrations, free vibrations of one-degree of freedom and multi-degree of freedom, simple harmonic, general period and random	3(3-0-6)

forced vibrations, method and techniques to reduce and control vibration, vibrations off ship and off-shore structures, dynamics and vibration problems of propeller shafts and equipment, vibrations problems of ship panels and curved surfaces.

03501333 Ship Dynamics 3(3-0-6)

Prerequisite : 01417267 and 03604223

Velocity and acceleration analysis, kinematics and dynamics force analysis, applications and balancing of mechanical and marine systems, ship motions, damping and added mass due to ship motions, ocean wave, wave equation, ship response amplitude operators, encounter frequency.

03501334 Ship Hydrostatics and Stability 3(3-0-6)

Prerequisite : 03501212

Ship displacement, volume displacement, ship buoyancy, fresh water allowance, statical stability, Initial metacentric height, test of ship inclination, angle of list, angle of loll, curves of statical stability, dynamic stability, effect of movement of center of gravity, loss of metacentric height, effect of slack tanks, trim, longitudinal stability, loss of intact buoyancy, effect of flooding on stability, IMO recommendations on stability.

03501341 Ship Hydrodynamics 3(3-0-6)

Prerequisite : 03501241

Model testing. Dimensional analysis. Law of similitude. Inviscid flow. Potential flow. Water wave theories. Wave loads. Ship motion in wave. Computational fluid dynamics.

03501342 Ship Resistance and Propulsion 3(3-0-6)

Prerequisite : 03501241

Factors of ship resistance, frictional resistance, residuary resistance, wave-making resistance, Froude's law of comparison, ship model test, ship powering system, estimation of effective, propellers and propulsion power, propulsive power transmission, thrust deduction, hull efficiency, wake fraction,

marine propulsors, screw propeller geometry, law of similarity for propellers, openwater characteristics, propeller design procedure, propeller cavitations.

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| 03501343 | Marine Piping and Pump System
Prerequisite : 03501241 | 3(3-0-6) |
| <p style="margin-left: 40px;">Pipe and symbols. Pipe materials. Valves and fittings. Pumps types. Pump characteristic. Pump design. Instrumentation. Piping system calculation. Piping drawing. Marine piping systems. Operating and maintenance of piping system.</p> | | |
| 03501351 | Maritime Law and Convention for Marine Engineering | 3(3-0-6) |
| <p style="margin-left: 40px;">Introduction to maritime law, related International maritime conventions and national legislation, International convention for the prevention of pollution from ships, basic knowledge of anti-pollution equipment required by national legislation, basic knowledge of anti-pollution equipment required by national legislation, convention of the prevention of marine pollution by dumping of wastes and other matter (London Dumping Convention), International convention relating to intervention on the high seas in cases of oil pollution casualties, 1969, international convention on civil liability for oil pollution damage, 1969 (CLC 1969), responsibilities under the International conventions and codes, certificates and other documents required to be carried on board ships by International conventions, load lines responsibilities under the relevant requirements of the International convention on load lines, responsibilities under the relevant requirements of the International convention for the safety of life at sea, responsibilities under international instruments affecting the safety of the ship, passengers, crew and cargo.</p> | | |
| 03501352 | Ship Production and Safety in a Shipyard
Prerequisite : 03501322 | 3(3-0-6) |
| <p style="margin-left: 40px;">Theories and concepts of ship manufacturing processes. Casting. Hot and cold forming. Cutting, turning, shaping, drilling, milling, welding and surface finishing. Relationship of manufacturing processes and materials. Production cost estimation. Locations and layouts of the shipyard. Dry docks</p> | | |

and ships maintenance. Quality and inspection control. System control and safety operation of health and environment. Health, safety and environment. Fire protection system in a shipyard.

- 03501353 Ship Operations and Maintenance 3(3-0-6)
Marine engine fundamental, Boiler and steam plant in ship, oil purification, principles of pneumatic and hydraulic systems, principles of pump and valve, fluid flow and characteristics of major systems, principles of operation of air compressor, water generator, sewage treatment plants, marine steering gear and basic control systems, principles of cargo handling equipment and deck machinery. SMS and ISM code and maintenance.
- 03501355 Introduction to Maritime Law and Environment 3(3-0-6)
Introduction to maritime law and international convention. Occupational health, safety in work on the ship, dockyard, and factory. Awareness of the problems in working as well as to control, prevention, and correction. Laws related to safety in operation and environment.
- 03501361 Applied Numerical Method for Naval Architecture and Ocean Engineering 3(3-0-6)
Prerequisite : 01417267
Root finding method. Systems of equations. Function approximation. Numerical integral. Numerical method for differential equations. Laplace transform. Fourier transform. Numerical methods and its applications.
- 03501362 Computation in Naval Architecture and Marine Engineering 3(2-3-6)
Prerequisite : 03600011 and 03501361
Computer programming, numerical analysis and application on naval architecture and marine engineering problems, practical training on various kinds of ship design programs.

03501363	<p>Marine Mechanical Design</p> <p>Prerequisite : 03501221</p> <p>Fundamental of mechanical design, properties of materials, theories of failure, design of simple marine machine elements, rivets, welding and underwater welding, screw fastener, keys and pins including cargo handling equipment, shafts including bearings, clutches, gears for marine propulsion system, chains and ship anchors, ship mooring systems, design and sizing of outfitting, prevention of oil pollution in the sea and design project.</p>	3(3-0-6)
03501372	<p>Shipboard Electrical Machines</p> <p>Prerequisite : 03501271</p> <p>Principle, operation, type and efficiency of AC and DC generator, AC and DC motor, transformer and rectifier, AC and DC switchboard, electrical circuit protection, battery and lamp in marine usage, and electrical safety system.</p>	3(3-0-6)
03501411	<p>Ocean Systems Engineering</p> <p>Prerequisite : 417268</p> <p>Ocean system, requirements for marine resources, system development planning, factors in the marine system and environment, applications of system engineering to ocean, utilizing of hydrospace simulation in engineering works.</p>	3(3-0-6)
03501421	<p>Ship Structures III</p> <p>Prerequisite : 03501321</p> <p>Stress distributions. Local strength analysis. Panels under external loads. Ship stanchions loading from the strength of panels with grillage. Finite element method in ship strength analysis. Applications of computer software for ship structures analysis.</p>	3(3-0-6)
03501423	<p>Marine Corrosion</p> <p>Prerequisite : 03501322</p> <p>Role of corrosion engineering. Metallic materials and their applications in engineering purposes. Electrochemical corrosion principles. Influences of</p>	3(3-0-6)

environmental parameters on corrosion behaviors of metals. Forms of corrosion. Marine corrosion. Corrosion prevention and control. Failure analysis methodology. Case studies of corrosion failure of engineering equipment in marine environment.

03501425 Composite Structures 3(3-0-6)

Prerequisite : 03501321

Composite materials used in engineering. Calculation of characteristics of materials. Theory of composite structures. Strength. Buckling of composite plates and shells. Thermal stresses. Elements of the mechanics of sandwich structures. Applications of composite materials in ship structures.

03501427 Offshore Structure Design 3(3-0-6)

Prerequisite : 03501322

Simply supported beams. Loading, shear force and bending moment diagrams. Detail design of large steel girders, flange and web stiffeners. Design of columns. Fracture mechanics and crack growth. Beam strength, lateral and local buckling. Connection and stress concentration in complex structure.

03501443 Hydrofoil and Propeller Design 3(3-0-6)

Prerequisite : 03501341

Introduction to hydrofoil and propeller design. Lifting theories. Foil section analysis. Cavitations occurrence. Propeller geometry. Momentum theory of propeller. Propeller performance calculation. Propeller series data. Hydrofoil and propeller design using computational fluid dynamics.

03501445 Coastal Engineering and Management 3(3-0-6)

Coastal morphology, wave description and wave theory, short-term and long-term wave analysis, wave statistics, wave generation, near shore wave transformation and breaking, tides and water levels, coastal erosion and accretion, coastal structures, environmental impact assessment for coastal structure.

03501446	<p>Marine Engineering</p> <p>Prerequisite : 03501342</p> <p>Alignment analysis of marine propulsion. Power and speed interactions among engines. Ship fuel. Ship propellers and hulls. Analysis and design of transmission system. Analysis and design of combination primmover. Anlysis and design of sharing power of auxiliary machinery and propeller from primmover.</p>	3(3-0-6)
03501452	<p>Offshore Engineering</p> <p>Offshore oil and gas industry, oil and gas properties, petroleum reservoir, petroleum exploration, offshore environment, offshore platforms, petroleum drilling, well types, petroleum production, subsea engineering.</p>	3(3-0-6)
03501454	<p>Offshore Operations</p> <p>Prerequisite : 03501322</p> <p>Marine operations of offshore floating structures, environmental and stability considerations and criteria, principles of transportation and installation of platforms, field installation of platforms, planning of marine lifts, crane and crane vessels, fire and basic principles of protection systems, basic principles of offshore drilling.</p>	3(3-0-6)
03501456	<p>Petroleum Development and Production</p> <p>Global oil and natural gas industry, concession and exploration, introduction to petroleum economics, petroleum field development, offshore platform alternatives and selection, front-end engineering design, engineering procurement, field development plan, offshore platform construction and fabrication, offshore platform transportation, installation and commissioning, offshore project management, production of petroleum, production planning, artificial lift techniques, enhanced oil recovery.</p>	3(3-0-6)
03501457	<p>Subsea Engineering</p> <p>Subsea field development, subsea manifolds and distribution system, subsea control and power supply system, subsea pipelines, subsea pipeline ends and structures, subsea wellhead, subsea umbilical system and risers,</p>	3(3-0-6)

subsea surveying, subsea positioning and installation, subsea project execution and interface, subsea integrity management, remotely operated underwater vehicles.

- 03501458 Petroleum Drilling Technology 3(3-0-6)
- Drilling system and equipment, drilling fluid, flow and associated pressure in the rotary rig, drilling bit hydraulic system, transport of drilled cuttings, prevention and control mechanics of well blowouts, directional and horizontal drilling, drill bit mechanics, drill string design, drilling problems and solutions, casing and cementing design, drilling planning.
- 03501459 Shipyard Management 3(3-0-6)
- Principles of management, production management and shipbuilding industry including related industries, shipyard organization, shipyard facilities and equipment, shipbuilding process, planning scheduling and production control, management by optimization, information systems management, case study in shipbuilding.
- 03501461 Ship Design 3(3-0-6)
- Prerequisite : 03501334 and 03501342
- Preliminary ship design to meet user's general requirements. Ship type. Principal dimensions. Form. Power requirements. Ship stability. Outfitting of ship. Ship structural design. Preliminary design drawings. Applications of computer-aided ship design programs.s.
- 03501462 Modern Marine Vehicles Design 3(3-0-6)
- Design of various kinds of modern marine vehicles. Design concepts and developments of marine robotics. Structural design and choices of materials. Microcontroller basics for maritime engineering. Thruster configurations. Energy consumption and powering the vehicles.

- 03501463 Computer-Aided Naval Architecture and Ocean Engineering 3(2-2-5)
Prerequisite : 03501241 and 03501321
Fundamentals of finite element method and computational fluid dynamics. Solutions of finite element equations. Partial differential equations and discretization methods. Algorithms for the calculation of the flow-field and heat transfer. Applications of finite element and computational fluid dynamics programs for maritime engineering problems.
- 03501465 Offshore System Design 3(3-0-6)
Prerequisite : 03501322
Flow of multiphase and non-Newtonian at high pressure and varying temperature. Design of process equipment on an oil producing offshore installation. Characterisation of crude oil and natural gas. Phase separation of gas, oil and water, separator design and phase separation theory. Design for constructability, maintainability and operability. Transportation phenomena and pipeline design.
- 03501466 Submarine Design Analysis 3(3-0-6)
Prerequisite : 03501461
Principles of submarine design, objectives and operations; structural analysis of submarine design; propulsion and auxiliary systems; safety systems.
- 03501472 Ship Control Systems 3(3-0-6)
Prerequisite : 01417267 and 03501271
Automatic control principles. Analysis and modeling of linear control elements. Stability of linear feedback systems. Design and compensation of control systems. Time domain design. Lead and lag compensator design. Frequency response. Application of control theory to steering systems and fin action. Ship motion control. Marine robotics, and auto pilot system.
- 03501473 Digital Technology and Artificial Intelligence in Maritime Engineering 3(3-0-6)
Digital technology in engineering. Principle of internet of things. Fundamental knowledges of artificial intelligence. Fuzzy logic. Machine

learning. Neural network and applications in naval architecture and marine engineering.

03501481 Heat Transfer and Marine Thermal Energy System 3(3-0-6)

Prerequisite : 03604241

Concepts and models of heat transfer. Heat conduction. Heat convection. Heat radiation. Applications of heat transfer in many functions. Boiling and condensation. Heat exchange system and enhancement for heat transfer. Basic design of heat exchanger and thermal energy systems for application in ships.

03501482 Marine Refrigerator and Air Conditioner 3(3-0-6)

Prerequisite : 03501281

Basic knowledge of refrigeration and coefficient of performance. Modified vapor compression refrigeration cycles. System components analysis of the refrigeration in ship. General refrigerant and their properties and that specified under MAPOL recommendation. Evaporative cooling and cooling towers. Absorption refrigeration. Calculation of cooling load of refrigeration systems in ship. Freezing of foods in ship. Air condition in ship. Cooling load estimation of air conditioning systems in ship. Air distribution and duct system design in ship. Safety device and control under the SOLAS 2010 standard in merchant ship convention.

03501483 Marine Internal Combustion Engine 3(3-0-6)

Prerequisite : 03501281

Types and operation of marine internal combustion engines, design and parts of marine engine, thermo-chemistry and fuel processing, engine cycles, combustion in spark-ignition engine, combustion in compression ignition engine, ignition system, marine cooling system, air and fuel inductions, lubricant and lubrication system, propulsion and performance of marine diesel engine, marine engine vibration, fuel injection pump timing adjustment, measurement of crankshaft deflection in marine engine, pollution control system and emission elimination.

03501484	Boiler and Gas Turbines Prerequisite : 03501281 Type of boiler, the principle of boiler and gas turbine, properties of steam control systems and alarms, the use of steam turbines in the sea, gas cycle, brayton cycle, rankine cycle, to test and improve the water quality of the steam generator, inspection of steam boiler, gas turbines maintain and modify.	3(3-0-6)
03501485	Marine Diesel Engine Prerequisite : 03501281 Principle of diesel engine, rating and selection, engine control panel and monitoring system, installation, operation and maintenance of marine diesel engine.	3(3-0-6)
03501486	Ocean Renewable Energy Introduction to physical oceanography and ocean renewable energy resources. Marine current energy. Tidal energy. Wind energy and offshore wind farm. Wave energy. Ocean thermal energy. Salinity Gradient Energy. Utilization of marine renewable energy.	3(3-0-6)
03501490	Cooperative Education On the job training as a temporary employee according to the assigned project including report and presentation.	6
03501495	Naval Architecture and Ocean Engineering Project Preparation Preparation of project proposal. Literature review. Project planning. Progress report writing. Presenting project proposal.	1(0-3-2)
03501496	Selected Topics in Naval Architecture and Ocean Engineering Selected topics in naval architecture and ocean engineering at the bachelor's level. Topics are subject to change each semester.	3(3-0-6)

03501497	Seminar Presentation and discussion of interesting topics in naval architecture and marine engineering at the bachelor's level.	1
03501498	Special Problems Study and research in naval architecture and ocean engineering at the bachelor's level and compile into a report.	1-3
03501499	Naval Architecture and Ocean Engineering Project Prerequisite : 03501495 Engineering project of practical interest in various fields of naval architecture and ocean engineering. Engineering project execution. Report writing. Oral presentation.	2(0-6-3)

Required fundamental course descriptions

01403114	Laboratory in Fundamentals of General Chemistry Prerequisite : 01403117 Laboratory in Fundamentals of General Chemistry.	1(0-3-2)
01403117	Fundamentals of General Chemistry Atomic structure. Periodic table and periodic properties. Chemical bonds. Stoichiometry. Gases. Liquids. Solids. Solutions. Chemical kinetics. Chemical equilibria. Acids and bases. Ionic equilibria. Representative elements. Metals. Nonmetals and metalloids. Transition metals.	3(3-0-6)
01417167	Engineering Mathematics I Limits and continuity of functions, derivatives and applications, differentials, integration and applications, polar coordinates, improper integrals, sequences and series, mathematical induction.	3(3-0-6)

01417168	Engineering Mathematics II Prerequisite : 01417167 Vector and solid analytic geometry, calculus of multivariables functions, calculus of vector – valued functions.	3(3-0-6)
01417267	Engineering Mathematics III Prerequisite : 01417168 First order linear differential equations, linear differential equations with constant coefficients, Laplace transforms and inverse transforms, power series solutions, system of linear differential equations.	3(3-0-6)
01420111	General Physics I Mechanics, harmonic motion, waves, fluid mechanics, thermodynamics.	3(3-0-6)
01420112	General Physics II Prerequisite : 01420111 Electromagnetism, electromagnetic waves, optics, introduction to modern physics and nuclear physics.	3(3-0-6)
01420113	Laboratory in Physics I Prerequisite : 01420111 or Corequisite or 01420117 or Corequisite Laboratory for General Physics I or Basic Physics I.	1(0-3-2)
01420114	Laboratory in Physics II Prerequisite : 01420113 and 01420112 or Corequisite or 01420118 or Corequisite Laboratory for General Physics II or Basic Physics II.	1(0-3-2)
03603101	Introduction to Computer Programming Computer concepts. Computer components. Hardware and software interaction. EDP concepts. Program design and development methodology. High-level language programming.	3(2-3-6)

03604111	Engineering Drawing	3(2-3-6)
	Lettering. Orthographic projection. Orthographic drawing and pictorial drawing. Dimensioning and tolerancing. Sections. Auxiliary views and development. Freehand sketches. Detail and assembly drawing. Basic computer-aided drawing.	
03604223	Basic Principles of Engineering Mechanics	3(3-0-6)
	Prerequisite : 01417167	
	Force systems and resultant. Equilibrium. Dry friction. Application of equilibrium equations to structures and machines. Fluid statics. Kinematics and kinetics of particles and rigid bodies. Newton's laws of motion. Principles of work and energy. Impulse and momentum.	
03604241	Thermodynamics I	3(3-0-6)
	Prerequisite : 01417167	
	Properties of pure substances. Ideal gas. Basic heat transfer and energy conversion. First law of thermodynamics. Second law of thermodynamics and Carnot cycle. Entropy.	
03604281	Workshop Practice	1(0-3-2)
	Practice in work-piece measuring, gas and arc welding, metal sheet works, lathe works, safety in workshop.	