COURSE OUTLINE FOR STUDENTS AT NTU

Academic Year	2023/24	**Semester**	1
Course Coordinator	Ang Hock Eng		
Course Code	MA4856		
Course Title	Naval Architecture and Marine Engineering		
Pre-requisites	MA2079 Engineering Innovation and Design		
No of AUs	3		
Contact Hours	Lectures: 39 hours		
Proposal Date	April 2023		

Course Aims

This course aims to provide you with a basic understanding of naval architecture and marine engineering principles and practice. The course will be taught in the context of a ship system that operates in a harsh sea environment in fulfilling its design function. Hence, for naval architecture, a basic understanding of a ship's hull form, stability and overall structural strength and the powering requirements in order to fulfill its functions are addressed.

On the marine engineering portion of the subject, you will be introduced to main machinery systems and electrical systems that enable a ship to be operated, focusing on ship propulsion and main engine systems, and the support services that make the ship habitable.

Intended Learning Outcomes (ILO)

Upon successful completion of the course, you will be able to:

1) Explain and calculate the relationship between hull form, stability, overall strength, and powering requirements.
2) Use the concepts and theories of naval architecture to make sound design decisions that may influence operations relating to ship repair, ship retrofit and new buildings.
3) Use a design based approach to describe ship propulsion and ship powering requirements
4) Compare and select appropriate marine power plants to propel a ship.
5) Explain thermodynamic analysis of main power plant options such as diesel, gas turbine and steam

engines, as well as ship service systems such as refrigeration and air conditioning, steam and compressed air systems.

6) Select, size and analyse the marine diesel engines and associated auxiliary systems

Course Content

	Topic	Hours
1.	**Ship Layout & Stability** Introduction. Types of ships. General Arrangement. Regulatory issues in naval architecture and marine engineering. Ships' Lines, Numerical Integration (e.g. Simpson's rules), Archimedes' principle, Hydrostatic curves, Effects of weights on trim and draft, Initial Stability, Inclining experiment, Watertight subdivision, and Damaged	6
2.	**Ship Structural Strength** Longitudinal bending – Hogging and sagging due to wave, Buoyancy curve, weight curve, the load curve, the shearing force and bending moment curve. Maximum Bending Moment in hogging and sagging condition, Bending theory, Calculation of section modulus, Bending Stress	6
3.	**Ship Resistance** The influence of sea waves, Dimensional Analysis, Components of resistance – frictional, wave, appendage, etc. The use of models to determine ship resistance, and influence of hull form. Powering of ships.	3
4.	**Ship Propulsion** Ship propulsion – propellers and other propulsive devices. Maneuvering devices – rudders, thrusters. Introduction to marine power plants. Shafting and transmission.	6
5.	**Marine Power Plants** Diesel engines, turbochargers and associated diesel engine auxiliary systems. Gas turbine and Steam Turbine plants.	7
6.	**Advanced Power Plant Technologies** Hybrid and electric propulsion systems. Power plant performance testing. Computer-aided engine performance and condition monitoring.	5
7.	**Ship Service Systems** Auxiliary boilers and steam systems, air compressors, refrigeration, air conditioning, water distillation, and fire protection and fighting systems.	6

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team/ Individual	Assessment rubrics
1. Continuous Assessment 1 – Coursework Project	LO#1 – 4, 6	*EAB SLO* *a, b, c, d, e, f, g, h, i, j, k*	40%	Team	
2. Final Examination – Restricted Open Book; 1 double sided A4 reference sheet; 2.5hrs	LO#1 - 6	*EAB SLO* *a, b, c*	60%	Individual	
Total			100%		

* EAB SLO stands for the Engineering Accreditation Board Student Learning Outcomes. The list is below:

a) **Engineering knowledge:** Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems

b) **Problem Analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c) **Design/development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

d) **Investigation:** Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

e) **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f) **The engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g) **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for the sustainable development.

h) **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i) **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.

j) **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k) **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l) **Life-long Learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Formative feedback

- There are weekly consultations between the professor and you. You need to inform the professor the ship type or offshore platform, you and your team members will be working on. You are encouraged to think critically on your choice of ship type or offshore platform and raise any questions and your professor will clarify your doubts.

- During the interactions between the professor and yourself, you will be guided in selecting the ship type or offshore platform. During the presentation week, you have to present your selected ship type with reference to the brief guidelines of coursework project component as indicated below. Your presentation will be subjected to queries and feedback from the tutors as well as your classmates. You are encouraged to evaluate the feedbacks so as to improve on your presented ship type or offshore platform.

- When the selected ship type has been approved by the professors, you will then perform an analysis of the related marine engineering aspects and the naval architecture aspects. The professors will give feedback to you during each stage of the project. You have to submit your individual logbooks together with the final report as a team on due date.

The typical guidelines and the requirements of the report are provided below.

In Marine Engineering (ME) aspects, you can discuss on marine propulsion plant, such as: combined propulsion plant, eg: CODOG, CODAG, COGOG & propulsors, mechanical and electrical systems, ship services & auxiliary systems.

In the Naval Architecture (NA) aspects if a catamaran is selected as a basis ship, you may wish to address the following issues (but not limited what are given here)

- The twin hull and its influence on resistance, powering and engine layout.
- The high transverse stability.
- Longitudinal structural strength.

Each of the ship or platform type has special design features as a result of fulfilling design requirement from both the naval architecture and marine engineering perspectives. It is important to consider both perspectives. In addition, these design features are required to comply with international conventions and resolutions (e.g. SOLAS, MARPOL etc.) given by International Maritime Organisation (IMO).

List of ship or offshore platform types

Commercial Vessels	Naval Vessels / Offshore Exploration or Production Rigs or Platforms
Bulk carrier , Cargo vessel, Container ,Chemical carriers Refrigerated cargo vessels, Livestock carriers, Fishing vessels ,Catamaran , LNG Carrier , LPG Carriers Roll on –Roll off vessel . Passenger liner , Cruise liners .	Patrol boats, Off shore Patrol Vessel, Corvette , Frigate ,Aircraft Carrier, Landing craft, Logistic support vessels, Minesweeper, Minehunter, Oceanographic survey vessel Submersibles/Semi-submersibles, SPAR, Tension Leg Platforms , Drillships ,Offshore Gravity Structures ,Ice Breaker FPSO, FSO or FSP vessel Tug, Tanker ,Supply Vessel, SWAFT ship

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Lectures	Provide fundamental principles and knowledge of naval architecture aspects in hull form, buoyancy, stability, overall strength. To explain thermodynamics principles in marine power plant and ship auxiliary systems. To determine ship propulsion requirements and design based on ship powering needs.
Practical	To investigate and discuss critically on the various aspects of Naval Architecture(NA) and Marine Engineering (ME) for a ship type or offshore platform,

Reading and References

Textbook

1. Rawson, K. J. & Tupper, E. C., Basic Ship Theory (5th edition), Butterworth- Heinemann, 2001

References

1. Principles of Naval Architecture. Society of Naval Architects and Marine Engineers.
2. Muckle, W., Strength of Ships' Structures, Edward Arnold Publishers Ltd, 1967.
3. Watson, D. G. M., Practical Ship Design
4. Harrington RL (ed), Marine engineering, Society of Naval Architects and Marine Engineers, 1992.
5. Cowley J (ed), The running and maintenance of marine machinery, Institute of Marine Engineering, Science & Technology, 1992
6. Woud,H.K. & Stapersma, D, Design of propulsion and Electric Power Generation S, IMarESTystem,2002.

Course Policies and Student Responsibilities

As a student of the course, you are required to abide by both the University Code of Conduct and the Student Code of Conduct. The Codes provide information on the responsibilities of all NTU students, as well as examples of misconduct and details about how students can report suspected misconduct.

The university also has the Student Mental Health Policy. The Policy states the University's commitment to providing a supportive environment for the holistic development of students, including the improvement of mental health and wellbeing.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
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Planned Weekly Schedule: Naval Architecture & Marine Engineering

Week	Topics	Course LO	Readings/ Activities
1	**Introduction to Naval Architecture**, Types of ships, General arrangement, Regulatory issues	1, 2	Rawson, K. J. & Tupper, E. C Watson, D. G. M.,
	Ship's Lines, Hydrostatics, Form coefficients, Archimedes' principle		
	Numerical Integration (e.g. Simpson's rules)		
2	Application of Simpson's rules		Rawson, K. J. & Tupper, E. C
	Effects of weights on trim and draft		

	Initial Stability, Inclining experiment	1, 2	Watson, D. G. M.,
3	Watertight subdivision and Damaged stability **Ship Structural Strength :**Longitudinal bending, Hogging and sagging due to wave, structural components Buoyancy curve, weight curve, the load curve	1, 2	Rawson, K. J. & Tupper, E. C Watson, D. G. M.,
4	Maximum bending moment in hogging and sagging Influence of wave on longitudinal strength Bending theory and calculation of section modulus	1, 2	Rawson, K. J. & Tupper, E. C Watson, D. G. M.,
5	Ship Resistance: Influence of sea waves, Dimensional analysis Components of resistance, Powering of ships The use of models to determine ship resistance	1, 3	Rawson, K. J. & Tupper, E. C Watson, D. G. M.,
6	Propeller design, Use of propeller charts, Hull Propeller Interaction Overall and quasi propulsive efficiencies & Revision	3	Rawson, K. J. & Tupper, E. C Watson, D. G. M.,
7	**Introduction to Marine Engineering,** Marine machinery and marine power plants Power plant concepts : mechanical concept Power plant concepts : electrical concepts	4	Woud, H.K. & Stapersma, D,
	RECESS WEEK		
8	Ship Service Systems: Air compressor and compressed air systems,. Ship Service Systems: Distillation Plants Ship Service Systems: Fire Prevention and Fire Fighting Systems.	6	Woud, H.K. & Stapersma, D,
9	Ship Propulsion: Definition of Power, Propellers and Propulsion Devices. Ship Propulsion: Propeller Cavitation, Propeller Design (Materials and Production), Propeller Maintenance and Repair. Maneuvering Devices: Rudders and Rudder Theory.	3	Woud, H.K. & Stapersma, D,
10	Shafting and Transmission: Introduction, Terminology, Arrangement and Design Shafting and Transmission: Propeller Shaft Defects, Shafting Systems, Shafting and Transmission: Stern Tube Bearings, Revision	3	Woud, H.K. & Stapersma, D,

11	Diesel Engines –introduction , thermodynamic analysis and application	5	Woud, H.K. & Stapersma, D,
	Steam and Gas Turbine Plant		
	Electrical components & machines		
12	Propulsion chain, matching engines to propellers	3, 5, 6	Woud, H.K. & Stapersma, D,
	Ship Services: Auxiliary Boilers, steam system, Refrigeration & Air-conditioning,		
13	Advanced power plant technologies : Intro to emerging technologies, Hybrid & electric propulsion system	4, 5	Woud, H.K. & Stapersma, D,
	Advanced power plant technologies : Intelligent Engines, Electronic engine control, Condition monitoring		
	Advanced power plant technologies: Emission control , Fuel Cells		