COURSE OUTLINE FOR STUDENTS AT NTU

Academic Year	2023/24	**Semester**	2
Course Coordinator	Ang Hock Eng		
Course Code	MA4808		
Course Title	Marine Control Systems		
Pre-requisites	MA2079 Engineering Innovation and Design (NA to Ex..Student)		
No of AUs	3		
Contact Hours	Lectures: 39 hours		
Proposal Date	April 2023		

Course Aims

The objective of this course is to provide you with a broad introduction to the concept of electromechanical, electro-hydraulic power transmission and its control in marine engineering systems. The underlying engineering fundamentals, characteristics of the components of systems will be covered. The functions of electromechanical components and their applications in the control of electrical power systems will be introduced. These electrical control techniques are vital in enhancing the proper performance and protection of the marine system equipment. The concepts of electro-hydraulic control systems will be introduced, followed by practical examples of their applications in marine engineering systems. The principles of pump selection and piping arrangement in marine engineering systems will be covered. An efficient pumping and piping systems is essential for the safety and correct operation of marine installations. The concepts of control techniques will enable you to understand the processes in implementing computer-controlled techniques in marine engineering systems.

Intended Learning Outcomes (ILO)

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

1. Select and size the electric motors to match the torque speed characteristics of mechanical loads in Marine and Offshore Engineering installations.

2. Interpret and explain ladder diagram logic that are used in the control and protection schemes for the electric motors.
3. Interpret electro-hydraulic circuit-diagram and explain the principles of hydraulic circuit operation.
4. Select pumps and piping for installations in marine engineering systems.
5. Explain the various types of control techniques that are used for marine engineering systems.

Course Content

	Topic	Hours
1.	**Electrical Machines and Electrical Power Systems.** AC and DC machines. Torque-speed characteristics. Operating features and application. Electric motor control: starting methods, reversing, braking and speed-control. Three phase AC synchronous generators. Switch-gear, circuit breakers and	10
2.	**Fluid Power Control** Fluid power circuit components: electro-hydraulic and electro-pneumatics, pumps, actuators, proportional and servo valves. Hydraulic circuits. Application of fluid power control in marine auxiliary machinery: steering gear, cargo valve actuation,	10
3.	**Pumps and Piping Systems** Pump classification. Piping arrangement: bilge and ballast water system, oil fuel, cooling system, lubricating oil system, steam supply and feed-water system. Heat Exchangers. Piping materials. Valves.	10
4.	**Automation and Control** Controller types and elements, computer and programmable logic controllers,	9

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	LO1,4,5	*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	LO1 - 5	*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 type of piping system you and your team members are working on. You are encouraged to think critically on your choice of piping system 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 piping system. During the presentation week, you have to present your selected piping systems, main components and your concepts are 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 piping systems.

- When the selected piping system has been approved by the professors, you will then perform stress analysis and followed by material selection process for the pipings. The various types of flow and temperature control techniques will be implemented in the piping system. 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.

  Typical piping system on board a ship.

  - Steam and Steam Drain Systems
  - Condensate Water, Feed Water and Boiler Water Circulating Systems
  - Air Systems (Starting Air, Control Air, General Service)
  - Fuel Oil System
  - Lubricating Oil System
  - Cooling Water System (Sea & Fresh)
  - Fresh Water Service System
  - Sea Water Sanitary System
  - Fire and Ballast Water Systems
  - Bilge Water System (Clean Bilge, Oily Bilge Disposal, Waste Oil Disposal)
  - Inert Gas System
  - Exhaust Gas System

Learning and Teaching approach

Approach	**How does this approach support students in achieving the learning outcomes?**
Lectures	Provide fundamental principles and knowledge in Marine Control Systems which includes, electrical machines, electrical power

	generation& distribution, fluid power control, pump& piping system in marine application, heat exchanger, automation & control in marine systems.
Practical	To perform an analysis and discuss on the piping systems on board a vessel.

Reading and References

Textbook
Nil

References

1. Anthony Esposito, Fluid Power with application, Prentice Hall, 6th Edition, 2003.
2. James A Sullivan, Fluid Power, Theory &Application, Prentice Hall, 4th Edition, 1998.
3. F Don Norvelle, Electro-hydraulic Control Systems, Prentice Hall, 2000
4. Vincent del Toro, Basic Electric Machines, Prentice Hall, 1990.
5. J Cowley, The running and maintenance of Marine Machinery,6th edition,1992,The Institute of Marine Engineers
6. G.O.Watson, Marine Electrical Practice , Marine Engineering Series, Butterworth & Co
7. E.Souchotte, Marine Auxiliary Machinery, Marine Engineering Series, Butterworth & Co
8. J.Crawford, Marine and Offshore Pumping and Piping Systems , Marine Engineering Series, Butterworth & Co

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: Marine Control Systems

Week Nos	Contents	LO	Reading/ Activities

1	AC machines	1	Vincent del Toro, Basic Electric Machines
	AC machines		
	AC machines		
2	DC machines	1	Vincent del Toro, Basic Electric Machines
	DC machines		
	Electrical motor control		
3	Electrical motor control	1	Vincent del Toro, Basic Electric Machines
	Marine Electric Plant		
	Power Electronics		
4	Power electronics	1	Vincent del Toro, Basic Electric Machines
	Electric Propulsion Drives		
	Electric Propulsion Drives		
5	Pumps classification & Piping Arrangement	3	J Cowley, The running and maintenance of Marine Machinery
	Pump & Piping systems		
	Pump & Piping systems		
6	Pump & Piping systems	3	J Cowley, The running and maintenance of Marine Machinery
	Control Valves		
	Heat Exchangers		
7	Heat Exchangers	2	Anthony Esposito, Fluid Power with application
	Introduction to Fluid Power		
	Introduction to Fluid Power, Hydraulic Symbols		
	Recess Week (5^{th} March to 9^{th}March)	2	Anthony Esposito, Fluid Power with application
8	Hydraulic pumps & motors		
	Hydraulic pumps & motors		

	Flow control/Standard Hydraulic Circuits		
9	Standard Hydraulic Circuits	2	Anthony Esposito, Fluid Power with application
	Standard Hydraulic Circuits		
	Hydraulic Circuits in Marine Engineering Systems		
10	Hydraulic Circuits in Marine Engineering Systems	2	Anthony Esposito, Fluid Power with application
	Hydraulic Circuits in Marine Engineering Systems		
	Marine Automation Systems (MAS)		
11	Marine Automation Systems (MAS)	4	G.O.Watson, Marine Electrical Practice
	MAS & Measurement and Instrumentation (MI)		
	Measurement and Instrumentation		
12	Controllers	4	G.O.Watson, Marine Electrical Practice
	Controllers		
	Final Control Elements		
13	Final Control Elements	4	G.O.Watson, Marine Electrical Practice
	SCADA & Transmission		
	Summary		