Marine and Ship Systems Engineering

NOVEMBER 2021 – FEBRUARY 2022

(PERIOD 2 AND PERIOD 3)

Marine and Arctic Technology

Aalto University
School of Engineering

Contents

Marine and Ship Systems Engineering (MSSE)

Course Overview

The modern maritime industry has to confront a number of challenges. These include stricter maritime regulations, higher competitivity among shipping companies and significant fuel price volatility. On the other hand, alternative fuels and emerging technologies are providing countless opportunities for ship designers to succeed in offering sustainable and innovative solutions. Research & Development personnel within industry and research centers in academia actively engage in forming a new network to create innovative objectives and to optimize current situations. The Marine and Ship Systems Engineering (MSSE) course aims at bringing fresh ideas from students into the maritime industry. This will be followed by insightful experience-based rethinking of proposed idea posed by specialists from academia and industries brightening the presented theoretical concepts for students.

"MSSE addresses the trade-offs faced when deciding on the alternatives for ship systems and how to select and justify the most optimal solution."

Intrigued…? Then you can take a closer look on the timetable including the lists of topics, but most important **Come along to the course lectures and find out more!**

MSSE page in Mycourse;
https://mycourses.aalto.fi/course/view.php?id=34003
For further information please contact Osiris Valdez Banda and Ahmad BahooToroody;
Osiris.valdezbanda@aalto.fi
ahmad.bahootoroody@aalto.fi

MSSE course structure

MSSE along with **Ship Design Portfolio** are courses, intending to refine the preliminary work done in **Principles of Naval Architecture** course**.** The materials in **MSSE** course should be useful for this iteration.

> *"Starting from concept design developed in **MEC-E1004 - Principles of Naval Architecture (PNA) course,** students outline the drawbacks and improve the ship design (preliminary design). The skills and knowledge, accumulated during M.Sc. studies are utilized."*

What is covered by **PNA** Course?

- The ship operational profile is defined, and the associated power demand is estimated
- Energy sources are briefly covered
- Ship machinery is widely covered which includes main systems: propulsion, maneuvering and accommodation energy
- Machinery systems (Main and auxiliary engines, power transmission), propulsor, anchoring, mooring, doors and hatches, evacuation, steering and maneuvering are discussed.
- General arrangement and an initial decision about the spaces reserved for machinery are covered

What is covered by **Ship Design Portfolio** Course?

This course covers all the topics taught in **PNA** and **MSSE**. The students go through a second iteration of the work done in **PNA** and **MSSE** to improve the design.

What should be covered by **MSSE** course?

Deliver the practical knowledge of ship systems to student in order to select the systems with clearer technical basis. **MSSE** should select some important ship systems and show the students how they can identify the available alternatives and the big players/manufacturers for each specific system. The course should also deliver the knowledge necessary for the students to be able to identify the multiple factors

considered when selecting a solution among the available alternatives. A list of the systems which will be covered through **MSSE** course are outlined in Table 1.

Table 1. topics and invited lecturers:

Topic	Time	Lecturer	Affiliation
System Engineering	08/11/21	Osiris Valdez Banda	Aalto University
Ship Energy sources	15/11/21	Mia Elg	Deltamarin
Safety Systems	22/11/21	Victor Bolbot	Aalto University
HVAC and ballast water treatment systems	29/11/21	Vesa Heikkilä/ Meriam Chaal	Meyer Turku/ Aalto University
Machinery auxiliary systems	13/12/21	Antero Apajalahti	Helsinki Shipyard
Propulsion Systems	10/01/22	Ari Rakkola	Meyer Turku
Deck Machinery and Cargo Handling Systems	17/01/22	Osiris Valdez Banda	Aalto University
Electricity consumption and Power Management System	24/01/22	Mia Elg	Deltamarin
Integrated Bridge and IT systems	31/01/22	Kalevi Tervo	ABB
Predictive maintenance of ship systems	07/02/22	Jeremias Tilander	Steerprop

MSSE Course content:

System Engineering

- The definition of systems engineering and its multidisciplinary utility.
- The application of systems engineering for ship design.
- The role of systems engineering in the selection of ship systems.

Ship Energy Source

- Common energy types onboard ships. The required systems for storing, circulating, and conditioning each energy source type.
- The potential future energy sources and the current barriers.

Machinery auxiliary systems

- The different ship machinery auxiliary systems: lube-oil system, steam plant, compressed air system, bilge water system, seawater cooling system, freshwater cooling system.
- The type and role of the main components in the machinery auxiliary systems: pumps, boilers, air compressors, filters, heat exchangers, freshwater generators.
- The factors to consider when selecting the main components of the machinery auxiliary systems.

Safety System

- The different types of life-saving appliances and evacuation systems.
- The factors to consider when selecting the type and number of life-saving appliances and evacuation systems.
- The different types of fire detection equipment and fire extinction systems onboard ships.
- The factors to consider when selecting the fire detection and extinction systems.
- Regulations concerning safety systems

Propulsion System

- The types of propulsion systems commonly installed onboard ships.
- The advantages and disadvantage of each propulsion system type.
- The components of each propulsion system type and the major companies in manufacturing these components.
- The factors to consider when dimensioning and selecting the components of the propulsion system and how to use the manufacturer catalogs.
- How to calculate the weight and space reservation for the selected propulsion system.
- The advantages and disadvantages of each energy source. The factors to consider when choosing the energy source of a ship.
- The methods to estimate the required amount of energy and space volume using the operational profile. The selection of the optimal location of the energy source for each type.

Electricity consumption and Power Management System

- The main components of the ship power plant. The big players/companies in ship power plants manufacturing.
- The main factors to consider when selecting the ship power plant.
- How to calculate the loading from different systems according to the operational profile. How to compute the total electricity consumption.
- Factors to consider when selecting the emergency power system and capacity. The applicable safety regulation and/or classification rules.
- The ship PMS automation strategy and functions and how to select it for the ship.
- How to calculate the weight and required space for the selected power plant.

Deck Machinery and Cargo Handling System

- The main components of deck machinery and their types. The major manufacturers of ship deck machinery.
- The factors to consider when selecting and dimensioning the deck machinery.
- The different cargo handling systems onboard ships (by ship type). The main components of each cargo handling system.

HVAC

- The main components of HVAC systems. The types of ventilated spaces onboard ships and the types of HVAC units for each space. The major companies in HVAC manufacturing.
- The factors to consider when selecting the HVAC system. How to estimate the capacity of the HVAC and which factors are considered for the calculation.
- How to calculate the power consumption from the HVAC and the weight and space reservation.

Ballast water treatment

- The main components of the ballast system and ballast water treatment systems. The big players/ companies in ballast water treatment systems manufacturing.
- The factors to consider when selecting the ballast water treatment system and capacity.

Integrated Bridge and IT systems

- The main components of the integrated bridge system and their functions. The big companies in IBS manufacturing.
- The main factors to consider when selecting the components of the IT and integrated bridge system.
- The main IT and automation systems of the ship. The role of these systems and their main functionalities. The big industry players in designing IT and automation systems for ships.

MSSE Course assignments:

Assignment 1: Identify your ship energy sources and their related systems

- Using the work, you developed during the concept design phase in PNA course, describe your ship project shortly. This includes the data of the reference ship, the operational profile of your ship project, the main dimensions, powering, and general arrangement.
- Identify and analyze the potential options of the energy sources for your ship using relevant literature
- Preselect two of the identified options and justify your choice. You may consider different advantages and disadvantages to justify the selection (+applicability to your ship profile, +innovation, -unacceptable cost, -safety concerns, etc.)
- Present a short application study of the energy source to your ship profile in the case of the two preselected options. Compare the applications and justify the final selection of your ship energy source.
- Based on the application studies you made, estimate the energy storage spaces volume, weight and location in the General Arrangement (GA).
- Identify, describe and present a layout of the required systems for conditioning and circulating the energy source to the main consumers. Reflect on the safety considerations; you can use classification rules (IACS)

Assignment 2: Select the HVAC and ballast water systems

- Define the type of spaces in your ship. Define the HVAC system for your ship: capacity and components. Select a HVAC system from relevant manufacturers and calculate its power consumption.
- Estimate the weight and volume of the HVAC system and locate the reserved space in the GA.
- Present the ballast tanks locations and volumes. You will need the PNA course outcomes. Define your ship ballast water system capacity accordingly (pumps numbers and capacity, ballast water treatment system if required). You will need to refer to the applicable regulation for ballast water treatment according to your ship operational profile.
- Select the ballast water system of your ship and calculate its power consumption, weight and reserved space in the GA.

Assignment 3: Select the propulsion system and its main components

- Investigate the potential alternatives of propulsion systems for your ship using relevant literature (Diesel, Diesel-electrical, Rotor sails, jet pumps, Fuel cells, etc.). You will need to check the applicable emission rules for your operational profile.
- Preselect two possible alternatives for your ship and define the machinery setup. Justify your choices of the alternatives and the setup (examples are number of engines, size, redundancy, transmission, etc.). Present a comparative analysis of the two selected options and justify the final selection.
- According to the selected setup identify the possible alternatives for each of the main components of the propulsion system for your ship. You can use the manufacturers catalogs. Select one option and justify your choice.
- Identify the required auxiliaries for the selected propulsion system components and present their layout. Refine the initial space reservation and weight for the propulsion system components and auxiliaries based on your selection.

Assignment 4: Estimate the total electricity consumption and select the power plant and PMS

- Define the loading from the different ship systems according to the operational profile. Compute the total electricity consumption.
- Identify and analyze the potential options for the power plant of your ship.
- Select the power plant for your ship and justify your choice. Describe the different components of the Power Plant and calculate the weight of the system with the reserved space volume. Locate the space in the GA.
- Select an emergency power source and capacity for your ship. Reflect on the applicable safety regulation and/or classification rules.
- Select the PMS automation for your ship and describe its important features.

Assignment 5: Make a final iteration of calculation with improvements and conduct a SWOT analysis

- Identify and describe the components of the Integrated Bridge System and other IT systems for your ship. You will need to refer to the relevant literature and the applicable safety regulation.
- Identify and shortly describe the safety systems, the cargo handling system, and the mooring and anchoring systems for your ship. Briefly reflect on the applicable regulation and the executed calculations for the selected systems.
- Make a final iteration of the calculation of your ship power consumers, their weight and space reservation. Present a final GA and weight calculation table. Indicate the rooms for improvement in next iteration rounds.
- Create an outline of all the identified systems in this course according to SFI-classification. You should add each system with the manufacturer reference/name and specification under the appropriate SFI section.
- Perform a SWOT analysis of your ship systems and summarize the key features about your ship systems.

1st Student Conference on MSSE 2022

Students themselves play an active role in getting prepared for the geo-scientific world of tomorrow. In addition to academic development, key skills include (international) collaboration, knowledge exchange and the development of organizational skills. Student Conference can provide a useful framework to facilitate this. The main theme of the conference will be structured according to different topics of Marine Ship System Engineering. There will also be the best paper award. Recipients of the Award receive a physical and electronic award banner and are recognized during the conference event. Depending on this first conference version, new plans can be developed for short- and long-term objectives, e.g., to integrate other Aalto maritime engineering courses to the conference, to receive paper from other universities in 3 years and become one of the well-known student conferences in marine technology sector in Europe in 10 years.

MSSE2022
Student Conference
Marine & Ship Systems Engineering

1st Student Conference on Marine and Ship Systems Engineering (MSSE) 2022

21 February 2022, Helsinki/ Espoo, Finland

What?

Aalto University is proud to host the 1st Student Conference on MSSE.

The ship mission for transferring goods would be impossible to fulfil without the relevant supporting systems. As the marine systems are constantly evolving and becoming more complex, the next generation engineers must be able to ensure their design in a systematic manner. MSSE2022 is aiming to bring fresh and new ideas of students into maritime industry. The topics that will be covered include but are not limited to:

- Ship fuels and energy Sources
- Power generation and management systems
- Ship engines and their auxiliary systems
- Propulsion systems
- Heating, Ventilation and Air Conditioning systems (HVAC)
- Integrated Bridge and IT systems
- Ballast water treatment systems
- Cargo handling systems
- Safety systems

Who?

The conference targets at M.Sc. level students willing to showcase their research and studies on marine and ship systems.

Why?

The conference participants will be able to

- Gain experience with writing scientific publications
- Receive feedback on their writing style and analysis from experts
- Showcase their studies to the local maritime community
- Establish novel connections

How?

The conference will be implemented in online with both physical and virtual attendance options possible.

Aalto University

When?

- 14th December Abstract submission
- 12th February whole paper submission
- 21st February Conference

Special Issue

The MSSE 2022 is linked to the Special issue "Marine and Ship Systems Engineering in Journal of Marine Science and Application". The most outstanding papers of the conference will be invited to submit the papers to this special issue

Organizing committee

D.Sc. Osiris Valdez Banda, Dr. Ahmad BahooToroody, M.Sc. Meriam Chaal
M.Sc. Sunil Basnet, Dr. Victor Bolbot

Contact Details

For more information about the MSSE2022 please contact Dr. Ahmad BahooToroody
ahmad.bahootoroody@aalto.fi

MSSE Comprehensive schedule:

Week	Date	Course description	Topics
1	01/11/2021	Introduction, Conference (specification of chapter and advisors)	
2	08/11/2021	Course leader lecture and Description of assignment 1	System Engineering
3	15/11/2021	Lecture + Assignment 1 tutorials	Ship Energy sources
4	22/11/2021	Lecture + Description of assignment 2	Safety Systems
5	29/11/2021	Lecture + Assignment 2 tutorials	HVAC and ballast water treatment systems
6	13/12/2021	Lecture + Conference topic selection (3hrs) + Description of assignment 3	Machinery auxiliary systems
Break between period II and period III			
7	10/01/2022	Lecture + Assignment 3 tutorials	Propulsion Systems
8	17/01/2022	Lecture + Description of assignment 4	Deck Machinery and Cargo Handling Systems
9	24/01/2022	Lecture + Assignment 4 tutorials + Description of Final report and assignment 5	Electricity consumption and Power Management System
10	31/01/2022	Lecture + Assignment 5 tutorials	Integrated Bridge and IT systems
11	07/02/2022	Lecture	Predictive maintenance of ship systems
12	14/02/2022	Advisor discussion about presentation	
13	21/02/2022	1st student Conference on MSSE 2022	

Important dates:

Assignment	Description	Submission deadline	Feedback
1	08/11/2021	22/11/2021	29/11/2021
2	22/11/2021	06/12/2021	13/12/2021
3	13/12/2021	17/01/2021	24/01/2022
4	17/01/2022	31/01/2022	02/02/2022
5	24/01/2022	08/03/2022	Final Grade