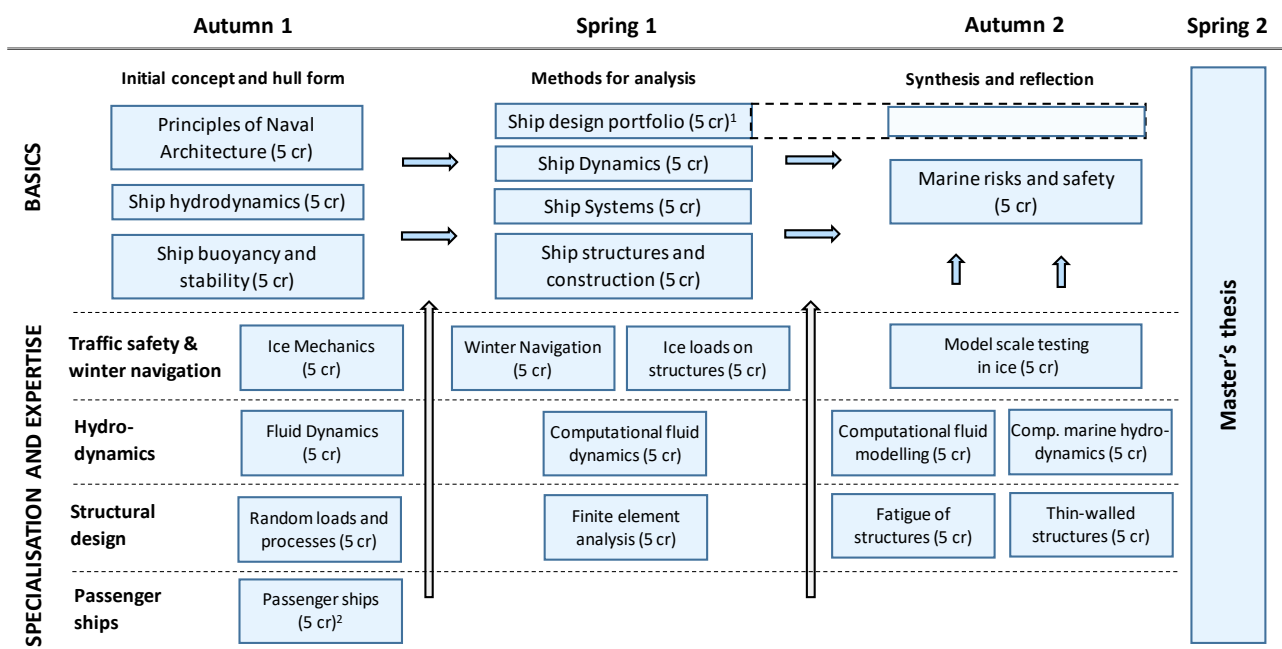# Marine Technology

Marine Technology education package gives an in-depth understanding of the maritime engineering. Teaching provides principles for construction and design, including hydrodynamics, loads, structural analyses, stability, safety of marine traffic and winter navigation. Teaching is carried out by assignments, project work, lectures, and workshops. Theory within this education package is supported by experimental work, and computer simulations are used to convey concepts. Student can select, for instance, the following study paths:

- **Naval Architecture**
- **Arctic Marine Technology**
- **Ship Project Engineer**
- **Structural Expert**
- **Hydrodynamic Expert**
- **Smart Maritime Operations**
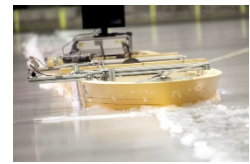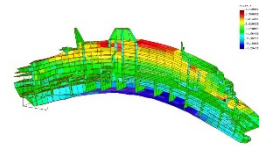
The selected study path can be modified and focused based on student interest by specialisation courses from other education packages and Master programme. For instance, the courses form other Aalto schools extends the engineering studies to design and business. **Marine Technology minor** provides good basic knowledge of the maritime engineering for students from other Master's Programmes at Aalto and FITech Universities, e.g. a student with major on ICT and digitalisation fields.

The education package provides students capability to perform design and research in marine industry. The majority of graduates work in design and research positions in shipyards, research institutes, design offices, shipping companies and regulatory institutions.

	Autumn 1	Spring 1	Autumn 2	Spring 2
BASICS	Initial concept and hull form	Methods for analysis	Synthesis and reflection	
	Principles of Naval Architecture (5 cr)	Ship design portfolio (5 cr)[1]		
	Ship hydrodynamics (5 cr)	Ship Dynamics (5 cr)	Marine risks and safety (5 cr)	
	Ship buoyancy and stability (5 cr)	Ship Systems (5 cr)		
		Ship structures and construction (5 cr)		Master's thesis
SPECIALISATION AND EXPERTISE — Traffic safety & winter navigation	Ice Mechanics (5 cr)	Winter Navigation (5 cr) — Ice loads on structures (5 cr)	Model scale testing in ice (5 cr)	
Hydro-dynamics	Fluid Dynamics (5 cr)	Computational fluid dynamics (5 cr)	Computational fluid modelling (5 cr) — Comp. marine hydro-dynamics (5 cr)	
Structural design	Random loads and processes (5 cr)	Finite element analysis (5 cr)	Fatigue of structures (5 cr) — Thin-walled structures (5 cr)	
Passenger ships	Passenger ships (5 cr)[2]			

Common studies and other supportive courses are selected based on the study path and student's interest

[1] Portfolio course can continue until the end of 2nd autumn to include all specialisation courses to ship project

[2] Course can be taken also 2nd autumn

Study path: Naval Architecture

Profile

Naval architect understands the ship as a system and the relation between different disciplines. Basic knowledge in fluid mechanics is essential to design the outer shape of the ship, which needs least amount of energy to be transported and is comfortable for the passengers. Ships can operate in ice-covered seas thus certain knowledge of ice mechanics is necessary. Main areas of ship design are covered: buoyancy and stability, dynamics, structure, systems and risk assessment. Ship concept design is developed in one course and improved in the other with justification for the courses chosen and final expert profile.

Studies

List of suitable courses for this study path is shown on the right, with recommended (RE) and optional (O) courses. All courses are 5 ECTS.

Work environment

Shipyard and design office, where innovative ship designs are created. Alumni example is a person, who is behind ground breaking concepts (e.g. "Oasis of the Seas" - the biggest cruise ship in the world) and out-of-the-box approaches to ship systems.

Courses

Common studies

Principles of Naval Architecture [1]	RE
Dynamics of rigid body [1]	RE
Fluid dynamics [1]	RE
Dynamics of structures	O
Random loads and processes	O
Finite element method in solids	O
Production engineering	O
Selection of engineering materials	O

Marine Technology

Passenger ships	O
Ship buoyancy and stability [1]	RE
Ship hydrodynamics [1]	RE
Ship structures and construction	RE
Ship design portfolio	RE
Marine risks and safety	RE
Ship dynamics	RE
Ship systems	RE

Fluid Mechanics

Computational marine hydrodynamics	O
Computational fluid dynamics	O

Arctic

Winter navigation	RE
Small scale testing in ice	O
Hydrodynamics in ice	O

Solid Mechanics

Finite element analysis	O
Thin-walled structures	O

[1] Recommended to participate in the first year autumn

Study path: Arctic Marine Technology

Profile

In Arctic marine technology the key competence is to understand the cold environment and its effects on the ship design, hull shape, power requirements, navigation in ice and safety of ships. This requires basic knowledge on ship design, risk analysis, solid and fluid mechanics and especially understanding of the characteristics of ice as a special material. Aalto ice tank will be utilised in the teaching as one course will concentrate on model scale testing in ice. In addition, a few day excursion to the icebreaker operating in the northern Baltic Sea is organised every winter as part of the winter navigation course.

Studies

List of suitable courses for this study path is shown on the right, with recommended (RE) and optional (O) courses. All courses are 5 ECTS.

Work environment

Shipyard, design and consulting offices, ship owners operating in ice, offshore companies where innovative arctic ship designs and operational plans for ice environment are created. Alumni example is s person, who works in an oil company and has e.g. active role in the recent large LNG projects in the Russian Arctic.

Courses

Common studies

Principles of Naval Architecture [1]	RE
Dynamics of rigid body [1]	RE
Fluid dynamics	O
Dynamics of structures	RE
Random loads and processes [1]	RE
Finite element method in solids	O
Selection of engineering materials	O

Marine Technology

Ship buoyancy and stability [1]	RE
Ship hydrodynamics [1]	RE
Ship structures and construction	RE
Ship design portfolio	RE
Marine risks and safety	RE
Ship dynamics	RE
Ship systems	RE

Arctic

Winter navigation	RE
Ice loads on structures	RE
Ice mechanics [1]	RE
Model scale testing in ice	RE

Solid Mechanics

Finite element analysis	O
Beam, plate and shell models	O
Fatigue of structures	O
Fracture mechanics	O
Thin-walled structures	O

[1] Recommended to participate in the first year autumn

Study path: Project Engineer

Profile

The project engineer must under-stand the interlinked design and production processes and manage the economical, production and technological risks associated with large one off prototype projects. It is essential to understand manufac-turing methods and quality man-agement methods as well as the role of material selection. Holistic project-based thinking and basic knowledge on ship technology is needed to create the future product in competitive fashion.
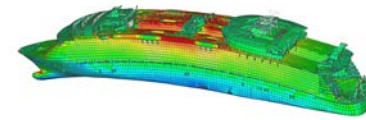
Studies

List of suitable courses for this study path is shown on the right, with recommended (RE) and optional (O) courses. All courses are 5 ECTS.

Work environment

Shipyard and equipment suppliers where innovative ship designs are created and building processes managed. Alumni example is a person who is behind managing the building of ground breaking prototype projects (e.g. "Oasis of the Seas" - the biggest cruise ship in the world) utilizing large supplier networks and extremely tight schedules.

Courses

Common studies
Principles of Naval Architecture [1]	RE
Dynamics of rigid body	O
Fluid dynamics	O
Dynamics of structures	O
Random loads and processes	O
Finite element method in solids	O
Machine design	O
Production engineering [1]	RE
Selection of engineering materials [1]	RE
Quality management and metrology [1]	RE

Marine Technology
Passenger ships	RE
Ship buoyancy and stability [1]	RE
Ship hydrodynamics [1]	RE
Ship structures and construction	RE
Ship design portfolio	RE
Marine risks and safety	RE
Ship dynamics	RE
Ship systems	RE

Engineering Materials
Welding technology and design	O
Engineering metals and alloys	O
Non-destructive testing	O

Production Engineering
Manufacturing methods I [1]	RE
Manufacturing methods II	O
Advanced manufacturing	O
Industrial project	O
Production systems modelling	RE

[1] Recommended to participate in the first year autumn

Study path: Structural Expert

Profile

Structural designer needs to understand structural design as part of overall design process and especially the random loads and the response and strength obtained. Rarely strength itself is selling argument for the ship, but it must be guaranteed and built in the way that ship is aesthetic yet strong and lightweight. Numerical methods for loads and strength assessment are essential tools, thus solid basis on mechanics is needed. Decision making, ship architecture and design and risk assessment are extensions to the professional profile that guarantee competitiveness in the markets.

Studies

List of suitable courses for this study path is shown on the right, with recommended (RE) and optional (O) ECTS.

Work environment

Shipyard, design offices and authorities where innovative ship designs are created and built and structural safety managed. Alumni example is a person who is behind managing the classification of architecturally extremely challenging structural concepts that have very high comfort and safety levels.
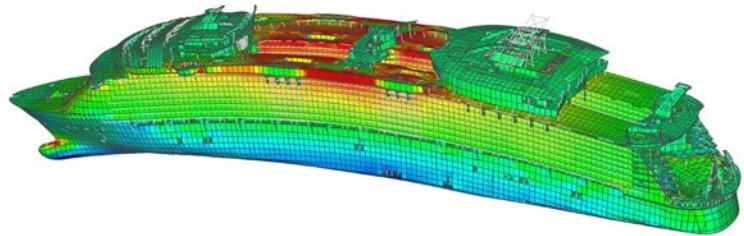
Courses

Common studies

Principles of Naval Architecture [1]	RE
Dynamics of rigid body [1]	RE
Fluid dynamics	O
Dynamics of structures	RE
Random loads and processes [1]	RE
Finite element method in solids [1]	RE
Selection of engineering materials	RE

Marine Technology

Passenger ships	O
Ship buoyancy and stability [1]	RE
Ship hydrodynamics [1]	RE
Ship structures and construction	RE
Ship design portfolio	RE
Marine risks and safety	RE
Ship dynamics	RE
Ship systems	RE

Fluid Mechanics

Computational marine hydrodynamics	O

Arctic

Ice loads on structures	O
Ice mechanics	O

Solid Mechanics

Finite element analysis	RE
Beam, plate and shell models	O
Fatigue of structures	RE
Fracture mechanics	O
Thin-walled structures	RE

Engineering Materials

Welding technology and design	O

[1] Recommended to participate in the first year autumn

Study path: Hydrodynamic Expert

Profile

An expert on hydrodynamics needs to understand the basic phenomena in fluid mechanics, the hydrodynamic design as part of the overall design process and the hydrodynamic performance as a whole covering the various aspects of ship hydrodynamics. Relevant field specific topics include static and dynamic stability, calm water resistance, propulsion, hydrodynamic loads and wave induced motions. The increasing role of computational fluid dynamics (CFD) in the design and analysis of ship flows means that an expert on hydrodynamics should have a solid understanding of the relevant computational methods.
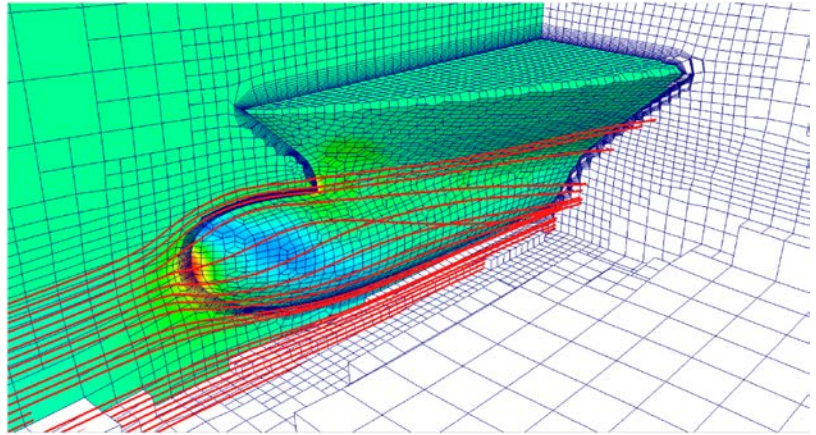
Studies

List of suitable courses for this study path is shown on the right, with recommended (RE) and optional (O) courses. All courses are 5 ECTS.

Work environment

Shipyards, propulsion equipment suppliers, ship design offices, consultancies, testing facilities and research institutes focusing on power requirements, motions and loads. Alumni example is a person working on the design of the state-of-the-art ship forms using the latest tools and technologies for minimum propulsion power and vibration levels.

Courses

Common studies

Principles of Naval Architecture [1]	RE
Dynamics of rigid body [1]	RE
Fluid dynamics [1]	RE
Dynamics of structures	O
Random loads and processes [1]	RE
Finite element method in solids	O

Marine Technology

Passenger ships	O
Ship buoyancy and stability [1]	RE
Ship hydrodynamics [1]	RE
Ship structures and construction	RE
Ship design portfolio	RE
Marine risks and safety	RE
Ship dynamics	RE
Ship systems	RE

Fluid Mechanics

Computational fluid modelling	RE
Computational marine hydrodynamics	RE
Computational fluid dynamics	RE

Arctic

Winter navigation	O
Ice mechanics	O
Model scale testing in ice	O

[1] Recommended to participate in the first year autumn

Study path: Smart Maritime Operations

Profile

Digitalisation has a growing impact on the marine industry with increasingly automated ship on-board control, navigation and communication systems as well as big data and optimization driven decision-making in operations.

The trend is from on-board monitoring, automation & control to wider utilisation, optimisation and connectivity of data including remote support and ultimately control and autonomy. This requires sound understanding of principles of naval architecture and related physics combined with a basic understanding of ICT to fully utilise novel solutions in the maritime business.

Studies

List of suitable courses for this study path is shown on the right, with recommended (RE) and optional (O) courses. All courses are 5 ECTS.

Work environment

Ship design companies, shipyards, component & technology suppliers, application developers, ship-owners or authorities developing ICT solutions for e.g. design tools, lifecycle modelling, concept optimisation, systems integration, data analytics, operations management and optimisation, sensors, health monitoring, safety management, novel user interfaces and user applications, e-navigation and autonomous operations.

Courses

Common studies

Principles of Naval Architecture [1]	RE

Marine Technology

Ship buoyancy and stability [1]	RE
Ship hydrodynamics [1]	RE
Ship structures and construction	RE
Ship design portfolio	RE
Marine risks and safety	RE
Ship dynamics	RE
Ship systems	RE

Computer Science

Human-Computer Interaction	RE
Information Security	O
Software Engineering	RE
Data Science	RE
Machine Learning: Basic Principles	RE
Artificial Intelligence	O
User-Cent. Meth. for Product and Service Design	O
Software Processes and Projects	O
Requirements Engineering	O
Software Architectures	O
Software Testing and Quality Assurance	O
User Interface Construction	O
ICT Enabled Service Business and Innovation	O
Introduction to Industrial Internet	O
Systems of Systems	RE
Computational Methods in Stochastics	O

[1] Recommended to participate in the first year autumn