COURSES SYLLABI

SEAS 4.0 Coordinator
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2nd GENERATION OF INTACT STABILITY CRITERIA

Title	**2ND GENERATION INTACT STABILITY CRITERIA**
Course Subjects	The course presents physical and mathematical background of the stability failure modes: parametric roll, pure loss of stability; surf riding, dead ship condition and excessive accelerations, considered by IMO 2nd Generation Intact Stability Criteria.
Objectives	The principal objective of the course is to contribute to a more profound understanding of the physics and ship dynamics faced within 2nd Generation Intact Stability Criteria. After two case studies on the application of the 1st and 2nd level of the SGISC criteria for different ship types, students should be able to link together the knowledge needed to.
Skills	Ability to perform stability failure analysis. Ability to find out the sound methodology for the direct assessment of stability failure modes Ability to use advanced techniques for ship dynamics modelling

ALTERNATIVE FUELS FOR SHIPPING

Title	**ALTERNATIVE FUELS FOR SHIPPING**
Course Subjects	Nowadays ship marine plants are heavily dependent upon the combustion of fossil fuels and as such contribute to increased atmospheric concentrations of greenhouses gases and concomitant impact on the world's climate. The new air emissions regulations established by IMO and other measures adopted by MEPC to mitigate and reduce ship emissions have inevitably influenced the business strategy and policies of the shipping companies, operators and other related shipping industries. The course offers a focus on the actual abatement technologies and alternative fuels able to satisfy both regulation requirements and business; secondly, hybrid power solutions and their impact on ship design will be examined in order to give a complete scenario of the design solutions adoptable in the next future.
Objectives	The main objective of the course is to examine first IMO regulation description and the available compliances methods (Low sulphur fuels, scrubbers, LNG propulsion); secondly, to explore new solutions (fuel cells, bio-fuel) for future applications, by means case studies, considering some ship type.

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Skills	Students are able to identify main fuel types and their characteristics Students are able to relate engine and fuel and their impact on environment and ship design Students are able to evaluate future solutions and their implications

ARCTIC TECHNOLOGY

Title	**ARCTIC TECHNOLOGY**
Course Subjects	The course will provide an introduction into ice engineering. Different kinds of ice and their different failure modes including numerical methods for ice load simulations are presented. Main design issues including design philosophies for structures and systems for ice covered waters are introduced. The course shall enable the attendees to understand the fundamental challenges due to ice covered waters and help them to understand ice engineering reports and presentations. The structural design under ice loads will be carried out for an individual case.
Objectives	The challenges and requirements due to ice can be explained. Ice loads can be explained and ice strengthening can be understood.
Skills	Professional Competence The challenges and requirements due to ice can be assessed and the accuracy of these assessment can be evaluated. Calculation models to assess ice loads can be used and a structure can be designed accordingly. Personal Competence Social Competence: Students are capable to present their structural design and discuss their decisions constructively in a group. Autonomy: Independent and individual assignment tasks can be carried out and presented whereby the capabilities to both, present and defend, the skills and findings will be achieved

AUTONOMOUS MARINE VEHICLES

Title	**AUTONOMOUS MARINE VEHICLES**
Course Subjects	The contents of this course includes concepts relevant to the software and hardware systems needed to develop autonomous vehicles, including motions, autonomous perception, location,

	mission planning and guidance, and an introduction to their practical application to the marine environment.
Objectives	The main objective of the course is to provide the students with an updated vision of autonomous robotics, and especially about intelligent control systems. In adittion, it will also provide a technical and regulatory approach to the field of robotics within an industrial framework, in particular autonomous marine robotics. In order to obtain these goals, and appart from the theoretical basis, students will work with real marine vehicles, thus developing the skills needed to tacke the implementation of real autonomous marine robots.
Skills	Capacity for applying mathematical and ICT methods and tools to define, design, operate and maintain advanced marine robotic systems and for understanding and developing the needed algorithms and methods.

COLLISION AND GROUNDING AS DESIGN CRITERIA FOR SHIP STRUCTURES

Title	**COLLISION AND GROUNDING AS DESIGN CRITERIA FOR SHIP STRUCTURES**
Course Subjects	Course deals with the problem of collision and grounding of the ships. These marine accidents are rare events, but often leading to serious consequences. As it is impossible to prevents these, and other similar accidents such as object drops, fires, explosive etc., it is worth studying them in the attempt to design crashworthy and safe structures. The course deals with the complexity of such non-linear problems. Background to the subject is given and then both internal mechanics and external dynamics of ships is studied during ship collision or grounding.
Objectives	Through the introduction to nonlinear finite element method analysis, obtain the knowledge needed for understanding, calculation and the analysis of the problems related to collision and grounding of ships as well as other fundamentally non-linear problems.
Skills	Students can understand the physics of non-linear problems in structural and fluid-structure interaction analysis Students can generate structural models and define analysis parameters for controlling non-linearities, contact problems and other parameters of analysis

	Students can understand the problem of stability of the non-linear computations and are able to make correct interpretation of the analysis results

DIGITAL TWIN IN MARINE SYSTEMS

Title	**DIGITAL TWIN IN MARINE SYSTEMS**
Course Subjects	Requirements and components of a digital twin. Simulation software for physical systems. Basic concepts of sensoring, data process and communications. Model fitting algorithms. Basic introduction to IoT and Digital Twin integration platforms. Practical development of a simplified Digital Twin.
Objectives	The objective of this course is to provide the students with knowledge in the field of digital twins, including the requirements, architecture and necessary components to develop one of these systems in the framework of the maritime sector. The contents of this course include the analysis of the typical architectures of digital twins and the methodologies for the development and integration of numerical models, sensoring and communication devices, model fitting tools and learning techniques and the available implementation platforms.
Skills	Knowledge regarding basic concepts, structure and design of digital twins within the maritime sector. Capability to practically develop a basic approach to a digital twin for a marine application.

FUNDAMENTALS OF SHIP VIBRATION

Title	**FUNDAMENTALS OF SHIP VIBRATION**
Course Subjects	Oscillation of singe-degree of freedom systems, vibration of beam and plates, analytical and numerical methods, finite element method, vibration excitation forces on ships, added mass in vibration analysis, ship structural responses, vibration criteria, vibration measurements.
Objectives	Presentation of the basic notions of the vibration theory and ship vibration. Definition of vibration problems and consideration of possibilities for their solutions. Reliable prediction of vibration level in the ship design stage. Review of vibration measurement procedures and vibration remedy.

Skills	Integrate advanced mathematics (particularly differential equations), Mechanics I, II, and Strength of materials in the analysis of vibrations of mechanical systems; Calculate natural frequency of discrete and continuous vibration systems; Calculate the amplitude of forced vibration of discrete and continuous vibration systems; Estimate the specific effects of stiffness, inertia and damping Solve dynamic problems; Integrate mathematics in the calculations of vibrational behavior of simple models of mechanical systems and comment their vibrational behavior; Calculate the basic geometrical and inertial characteristics required for the calculation of global vibrations of ship hull.

INDUSTRY 4.0 ENABLING TECHNOLOGIES

Title	**INDUSTRY 4.0 ENABLING TECHNOLOGIES**
Course Subjects	The Industry 4.0 paradigm has derived into the proliferation of devices connected to networks and physical processes. Such devices make use of multiple essential technologies that enable integrating them into industrial systems able to control, monitor and manage the different involved processes. This subject reviews the latest and most popular Industry 4.0 enabling technologies, including sensing/actuation networks, augmented/mixed reality, blockchain, unmanned vehicles (e.g., AGVs/UAVs), additive manufacturing, cloud/edge/fog computing systems and cyber-physical systems. Moreover, the subject emphasizes the different aspects involved in the cybersecurity of the studied Industry 4.0 technologies: their potential cyber-attacks and possible mitigation measures. Furthermore, the most relevant industrial information management systems will be analyzed and studied, like ERP (Enterprise-Resource Planning), PLM (Product-Lifecycle Management) and MES (Manufacturing-Excecution System) software.
Objectives	The main objective of this course is to provide the students with the essential concepts behind the latest and most popular Industry 4.0 enabling technologies, together with knowledge regarding the threats which could affect industrial connected systems.
Skills	To understand and acquire knowledge regarding many of the most important Industry 4.0 enabling technologies. To be able to understand the key concepts related to the most popular Industry 4.0 information management systems. To be able to understand the implications at a security level of the diverse Industry 4.0 technologies and the basics of potential cyberthreats and the essential protection techniques.

INDUSTRIAL INTERNET OF THINGS (IIoT)

Title	**INDUSTRIAL INTERNET OF THING**
Course Subjects	Introduction to IoT and IIoT. Applied architectures and devices (sensors and endpoints, actuators, power sources and hardware platforms). Types of networks (WAN, WLAN, WPAN), gateways and communication protocols. Data process (edge/fog computing, cloud computing, data analytics and machine learning, software platforms). User interfaces. Security.
Objectives	This course is focused on providing the students with practical knowledge in the Internet of Things (IoT) and, specifically, regarding its application to industrial environments (Industrial Internet of Things, IIoT). The theoretical lessons will cover a broad view of all relevant aspects of IoT, while practical lessons will prepare the students for carrying out the implementation of those theoretical concept
Skills	The students will be able to understand and implement the basic theoretical concept of Internet of Things in industrial environments.

INNOVATIVE CFD APPROACHES

Title	**INNOVATIVE CFD APPROACHES**
Course Subjects	Computational Optimisation, Parallel Computing, CFD-Procedures for GPU Architectures, Alternative Approximations (Lattice-Boltzmann & Particle Methods), Fluid/Structure-Interaction, Modelling of Hybrid Continua, Multi-phase flow approaches.
Objectives	Theoretical background of different CFD strategies and their use is simulations
Skills	Professional Competence Student can explain the theoretical background of different CFD strategies (e.g. Lattice-Boltzmann, Smoothed Particle-Hydrodynamics, Finite-Volume methods) and describe the fundamentals of simulation-based optimisation Knowledge Student should be able to structure and perform a simulation-based project independently Student should practice her/his team-working abilities, learn to lead team sessions and present solutions to experts

INTELLIGENT DECISION SUPPORT SYSTEMS

Title	**INTELLIGENT DECISION SUPPORT SYSTEMS**
Course Subjects	Random processes: mathematical representation and tools for analysis of stochastic processes (time and frequency domains); ocean waves. Modelling of dynamical systems: state space and input-output models for linear systems; response amplitude operators. Seakeeping: methods for computation and assessment of ship responses in waves; motions, loads and fuel consumption. Signal processing: methods and tools for processing of noisy signals in the time and frequency domain. Estimation theory: parametric methods for estimation of signals; Kalman filtering and particle filtering; sea state estimation. Detection theory: statistical learning; detection methods for Gaussian and non-Gaussian processes. Decision support systems: design of decision support systems; human factors; study cases on safe marine operations and fuel efficiency.
Objectives	The overall aim of the course is to provide an understanding of the engineering and mathematical analyses that form the basics of monitoring and decision support systems used for onboard/navigational guidance of ships. These techniques are used by naval architects and engineers in the technical departments of ship owners, in classification societies and ship consultancies. Moreover, the student will be trained in advanced methods to evaluate ship operations with regards to the increased focus on energy consumption and emissions from ship
Skills	Understanding of monitoring and decision support systems used for onboard/navigational guidance of ships and capability to evaluate and optimize ship operations with regards to energy consumption and emissions and safety.

INTRODUCTION TO MARINE COMPUTATIONAL FLUID DYNAMICS (CFD)

Title	**INTRODUCTION TO MARINE COMPUTATIONAL FLUID DYNAMICS**
Course Subjects	Introduction to Marine CFD. Conservation laws in fluids. Finite Volumes for diffusion and convection diffusion problems. Pressure-velocity coupling. Finite Volumes for transient flows.

	Concepts of turbulence and boundary layer modeling. CFD simulation process. Introduction to programming/simulation in OpenFoam.
Objectives	This course is focused on providing the students with an introduction to the field of computational fluid dynamics, with an application to the marine field. The course will cover from the basic principles of conservation and their characteristic equations, its discretization methods, to the finite-volume method and the basics of the CFD codes used for their solution, with a focus in the open source code OpenFoam.
Skills	Capacity to understand the basic concepts of computational fluid dynamics and to describe physical problems in this field with adequate mathematical models. Capacity to set up test related with the fluid dynamics in the marine field and to solve problems related with numerical and physical errors. Capacity to program a CFD tool based on C++ language.

MANOEUVRABILITY AND SHALLOW WATER SHIP HYDRODYNAMICS

Title	**MANOEUVRABILITY OF SHIPS**
Course Subjects	The main contents of this course include concepts regarding coordinates & degrees of freedom, the nonlinear governing equations of motion hydrodynamic forces & moments, rudder forces and rudder design, yaw stability, manoeuvring tests (constraint & unconstraint model tests), slender body approximation, the application of CFD simulations and the influence of shallow water, waves and wind.
Objectives	The main objective of this course is to introduce the students to the basic concepts for the assessment and prognosis of ship maneuverability and to the development of methods for the analysis of maneuvering behavior of ships, including also the basics of characteristics of flows around ships regarding ship propulsion and manoeuvrability.
Skills	Students will acquire the ability to develop methods for analysis of manoeuvring behaviour of ships and explaining the Nomoto equation. The students will know the common model tests as well as their assets and drawbacks. Students will be able to evaluate a rudder design and to design a rudder by themselves.

MULTI-CRITERIA DESIGN AND OPTIMIZATION

Title	**MULTI-CRITERIA DESIGN AND OPTIMIZATION**
Course Subjects	The course describes the Multi-Criteria for Ship Design and Optimization, analyzing each step, from the identification of design problem, through the formulation of design model, till the structure response calculation using FEM. Calculation of reliability and adequacy of structure and performed and. Modeling of "decision making" process are made.. Techniques for multicriterial optimization of structures are described. The course is integrated with practical examples and exercise
Objectives	Acquiring the knowledge and application of methods for optimization and multi-criteria decision making in engineering system (airplanes, ships …) design.
Skills	Apply optimization and multi-criteria design methods for solving design problems in a field of complex engineering systems design. Evaluate applicability of a particular design support methods with respect to the type and characteristics of a design problem and design problem mathematical model. Design complex engineering systems using advanced design support methods

NUMERICAL SIMULATION OF MARINE PROPULSION SYSTEMS

Title	**NUMERICAL SIMULATION OF MARINE PROPULSION SYSTEMS**
Course Subjects	Nowadays merchant ships, and especially naval vessels, are characterised by flexible and complex propulsion systems with powerful prime movers (e.g. gas turbines). The great power available to the propellers/waterjets entails a careful power management for a safe operation in every propulsive condition, including emergency ship manoeuvres. To this end, numerical simulation techniques can represent a very useful tool to design and optimise marine propulsion plants. In this regard, the course will deal with: Marine diesel engines and gas turbines performance; Dynamic ship propulsion models; Control logics in design and off design conditions; Time Domain Simulation;

Objectives	Provide students with examples of the use of simulation techniques in marine industrial applications; Apply simulation to the ship propulsion design process; Assess ship energy efficiency and dynamic performance by simulation
Skills	Ability to analyse numerical models, of different level, representing the dynamic performance of ship propulsion plants; Ability to develop simple control logics for ship propulsion systems; Ability to develop numerical simulation codes in Matlab-Simulink® environment

REGULATORY FRAMEWORK FOR MARITIME 4.0

Title	**REGULATORY FRAMEWORK FOR MARITIME 4.0**
Course Subjects	The course offers a comprehensive insight into the contemporary developments in the international maritime regulatory framework for safety and environmental protection. The course discusses the future of the maritime regulations in the era characterized by the fast-paced technology developments, globalization and climate change, resulting in demand for unconventional ships. Throughout the course a number of significant maritime accidents is used to exemplify the multifaceted nature of the regulations and (sometimes unexpected) implications for ship design.
Objectives	The principal objective of the course is to contribute to a more profound understanding of the international maritime regulatory framework and to strengthen capacities of the future Maritime 4.0 engineers for the critical analysis and successful implementation of the regulations in design and operation of ships.
Skills	Students are able to understand the contemporary and future development in the international maritime regulatory framework and to approach in a critical way to implementation of the regulations.

ROBOTICS

Title	**ROBOTICS**
Course Subjects	The course will start with an introduction about robotics, giving a highlight to the current economy and market, especially related to the field of interest.

	The basic concepts of robotic systems and kinematic structures will be presented, along with the direct and inverse kinematics problems and the trajectory planning problem. Dynamics and control of a robot manipulator will be treated. The course will finally introduce the technical nomenclature and required specifications in field robotics applications of interest.
Objectives	The sought goal of the course is to give the basic concepts and technical terminology. After completing this course, the candidate should understand the different robotic system configurations, the problems related to the robot control, the possible applications in the field of interest, and the technical specifications.
Skills	Students will be able to: understand the basic concepts of robotic systems and kinematic structures; understand the problems related to the robot control; think possible application of robotic system in their field of interest.

SHIP DAMAGE STABILITY

Title	**SHIP DAMAGE STABILITY**
Course Subjects	Introduction to ship damage stability. Practical methods to determine ship equilibrium after damage. Deterministic damage stability regulations. Probabilistic damage stability regulations (basic concepts of probability and current stability criteria). Practical implementation of deterministic and probabilistic damage stability regulations.
Objectives	The objective of this course is that the students acquire the capabilities needed for understanding the process of damage of a ship or floating structure, including the theoretical basis, the capability of solving practical cases and the knowledge and application basis of contemporary damage stability requirements.
Skills	To acquire the knowledge of the theoretical basis and the practical capabilities to analyse the stability of a ship or floating structure following damage, including its equilibirum, the residual stability levels and the verification of the applicable regulatory requirements.

SHIP DESIGN

Title	**SHIP DESIGN**
Course Subjects	Describe the sequential and concurrent approaches used in the development of ship design procedure. Involve the students into design procedure steps. Evaluation and ranking of existing ships. Overview on Ship types and general layouts. Influences of Regulatory frame on design development and on ship characteristics. Freeboard and GT Assessment. Evaluation of brake horsepower. Life Cycle Assessment. Design for dismission. Technical aspects of Ship Management and Infologistics. Future trends in Ship Design
Objectives	To provide students with state of the art knowledge on ship design development and optimization. To enable students to perform main ship characteristic preliminary assessment and to evaluate Regulatory frame influences. To enable students to consider the influences of Lyfe Cycle Assessment and Ship management and Infologistics on Ship design
Skills	Analysis and ranking of existing ships by Multi Attribute Decision Making and statistical approaches Students are able to identify ship types and their main design features Students are able to assess main ship characteristics and pertinent Regulatory frame on the basis of given mission profile Students are able to perform a preliminary Life Cycle Assessment and to identify key roles in Ship management

SHIP MANAGEMENT AND INFOLOGISTICS

Title	**SHIP MANAGEMENT AND INFOLOGISTICS**
Course Subjects	New trends and tools for Ship Mangement. Compliance with safety and environmental Regulatory Frame. Infologistiscs and its implications on Ship design
Objectives	Provide students with the whole picture of technical aspects of Ship Managements Provide information about most common tools used in Infologistics by Shipping Companies
Skills	Ability to work as Ship or Fleet Manager Basic Ability to manage Infologistics tools

SHIP SEAKEEPING

Title	**SHIP SEAKEEPING**
Course Subjects	Wave Theories; Frequency Domain Analysis Of Waves; Ship Response In Regular Waves; Ship Behaviour In Rough Sea; Seakeeping Criteria In Ship Design; 2nd Order Phenomena; Time domain simulations in seakeeping
Objectives	Understanding the mathematical model for ship behaviour in rough sea; understanding of pros and cons of different theoretical, numerical, and experimental methodologies used in seakeeping of ships and offshore structures. Ability to set up a problem and use of properly selected tools and methods. Ability to "define" the seakeeping criteria at the design stage. Ability to write a technical report throughout three project assignments during the course
Skills	Problem solving and critical thinking; Becoming familiar with the use of key design tools in naval architecture and marine engineering Understanding sea-keeping characteristics and implications on design Developing effective communication and presentation skills for the final report

SHIP STRUCTURAL DESIGN

Title	**SHIP STRUCTURAL DESIGN**
Course Subjects	The course will discuss main aspects of ship structural design starting from the design spiral on the general and structural level. Relevant methodology and methods (analytical and numerical) for ship structural design in different design phases will be presented and evaluated.
Objectives	Upon course completion students will be able to: Formulate design problem in area of ship structural design; Understand regulatory framework for ship structural design Choose relevant design models for rational ship structural design; Apply knowledge and principles in ship strength and optimization technique in rational ship structural design Use advanced modelling techniques for ship structures in contemporary computer tools in order to obtain rational design variants;

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	Use profession specific foreign language (English) regarding the design and analysis of ship structures;
Skills	Apply advanced knowledge in engineering sciences for the purpose of solving complex technical problems in the field of naval architecture and offshore engineering. Solve new problems by applying acquired knowledge about elements of technical systems and processes, and their interactions. Use advanced techniques for modelling technical systems and processes for the purpose of the creative solving of complex problems in the field of naval architecture and ship structural design. Evaluate solutions and calculations of elements of technical systems and processes in the field of naval architecture. Design ships and offshore structures and manage the preparation of technical documentation.

SIMULATION AND OPTIMIZATION OF SHIPBUILDING PROCESSES

Title	**SIMULATION AND OPTIMIZATION OF SHIPBUILDING PROCESSES**
Course Subjects	Course introduction. Basics of shipbuilding: introduction to basics of shipbuilding, processes, building strategy and shipyard arrangement. Discrete event simulation: applications, systems, models & simulation, types of simulations, discrete event systems and processes, terminology and architecture of a discrete event model. Flexim: introduction and programming in Flexim (discrete event simulation software). Practical cases: data analysis, time measurement, experiment realization and result analysis; practical case related with shipbuilding. Advanced simulation techniques: introduction to “Process Flow” technique. Optimization: linear programming, nonlinear programming, metaheuristics.
Objectives	This course is focused on providing the students with knowledge in the field of discrete event simulation, and its application for simulating and optimizing the processes involved in shipbuilding. In the course, lectures are divided among theoretical ones, where the main principles of discrete events simulation and optimization are included, with practical ones, where Flexim is used to solve realistic cases
Skills	Acquire knowledge about ship building strategy and the usual techniques applied during ship construction. Capability to understand and implement simulation and optimization strategies of ship building processes.

SMART SHIP DESIGN

Title	**SMART SHIP DESIGN**
Course Subjects	Life Cycle and Cost Assessment. Energy Efficiency Indexes Consideration. Compliance to present and future Regulatory Frames within Sustainability concepts. Ship Design Optimization Tools.
Objectives	Provide students with information about environmental and economic aspects linked to Ship Working Life to be implemented into Ship Design Provide information about present and future development of Ship and Shipping Regulatory Frame
Skills	Ability to perform updated Ship Design Optimization

STATISTICAL MODELS FOR MARINE TECHNOLOGY INNOVATION

Title	**STATISTICAL MODELS FOR MARINE TECHNOLOGY INNOVATION**
Course Subjects	Description of multivariate data and inference about mean vectors. Elements of unsupervised learning: principal component analysis and clustering methods. Elements of supervised learning: problems in multivariate linear regression models; linear model selection and regularization (ridge regression, the lasso); reduction methods (principal components regression, partial least squares). Overview of classification methods. Statistical process monitoring and control: control charts for variables and attributes; the Hotelling control chart; regression adjustment; interpretation of out-of-control signals. Case studies through software environment R.
Objectives	The course is applicative with the aim to train students on statistical tools for monitoring of complex data from marine technology systems. Applications and case studies are addressed to train students to formulate and define strategies for quality control and monitoring in order to support decision making process in a big data framework.
Skills	Ability to analyze data via regression analysis. Ability to use statistical tool to reduce the dimensionality of a dataset.

	Ability to perform analysis through R, an opensource package for statistics.

STRUCTURAL ANALYSIS OF SHIPS AND OFFSHORE STRUCTURES

Title	**STRUCTURAL ANALYSIS OF SHIPS AND OFFSHORE STRUCTURES**
Course Subjects	The course will discuss main aspects of ship structures. Regulatory framework and all relevant steps for scantlings determination of different structural elements using prescribed Rule based calculations will be explained. Relevant methodology and for ship structural analysis will be presented and evaluated.
Objectives	Upon course completion students will be able to: understand function of ship structural elements. implement basic design principles in ship structural design. use regulatory framework (Rules) for determination of ship structural elements scantlings. explain and classified load components acting on ship structure. give an overview of the basics of structural mechanics for the analysis of ships and offshore structures. explain structural models for thin-walled structures. specify problems of linear structural analysis, to identify them in a given situation and to explain their mathematical and mechanical background. classify finite elements with respect to their suitability for the structural analysis of ships and offshore structures. select a suitable finite element formulation for a given linear problem of structural mechanics. Use specific professional terminology regarding ship structures.
Skills	Apply advanced knowledge in engineering sciences for the purpose of solving complex technical problems in the field of naval architecture Solve new problems by applying acquired knowledge about elements of technical systems and processes, and their interactions. Use advanced techniques for modelling technical systems for the purpose of solving complex problems in the field of ship structural analysis. Evaluate solutions and calculations of elements of technical systems and processes in the field of naval architecture. Manage the preparation of technical documentation relevant for ship structures.

TRANSPORT ECONOMICS

Title	**TRANSPORT ECONOMICS**
Course Subjects	The course offers a comprehensive insight into the transport economical aspects of a maritime transport chain. This includes maritime (sub) markets, ports, hinterland transportation and emission reductions (legislation and current developments).
Objectives	The objective of this course is to provide the students the insights of how ships are used to earn money. In order to do so, the functioning of the maritime markets needs to be understood. Also, it is the aim to explain that ships are part of a larger logistics chain and that the interaction in the port and with the other transport modes is vital. Next to that, also the working principals of a port are explained even as hinterland transport. Finally, the current developments regarding emission reductions in the total transport chain are dealt with.
Skills	At the end of the course students will be able to understand how maritime world is part of a more complex logistic system and how ships and ports are integrated within it.

VIRTUAL AND AUGMENTED REALITY FOR LIFE CYCLE DESIGN

Title	**VIRTUAL AND AUGMENTED REALITY FOR LIFE CYCLE DESIGN**
Course Subjects	The course will discuss: VR and AR application in the Life Cycle of a ship The PDM-PLM environment for data management VR in complex system design Virtual Reality for Ship Design and Management Design Review in VR (Laboratory) Augmented Reality for operation and maintenance AR for Safety (laboratory)
Objectives	The overarching objective of the course is to give a thorough introduction to different topics related to key enabling technologies AR and simulation. After completing this course the candidate shall understand and have insight into: PLM/PDM environment; Virtual Reality technology;

	Augmented Reality technology.
Skills	The ability to work with PDM-PLM environment; The ability to use AR technology to inform operators when and where they need; The ability to use VR technologies.

VIRTUAL PROTOTYPING

Title	**VIRTUAL PROTOTYPING**
Course Subjects	The course will discuss: The V-model of product design The evolution from geometrical models to PDM-PLM environment Fundamentals of Reverse Engineering techniques Challenge topics concerning Design for Additive Manufacturing Virtual Reality and AR for Ship Design and Management Human Manikin and Human Machine Interaction
Objectives	The overarching objective of the course is to give a thorough introduction to different topics related to interactive design and simulation. After completing this course the candidate shall understand and have insight into: Geometrical modelling evolution; Reverse engineering techniques; Virtual and real prototyping; Virtual Reality and Augmented Reality in design.
Skills	The ability to understand a PDM-PLM environment; The ability to use photogrammetry or other techniques to capture point cloud of free form shape. The ability to understand VR and AR technologies.