Module Manual

Master of Science (M.Sc.)

Naval Architecture and Ocean Engineering

Cohort: Winter Term 2022

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Program description

Content

The Master Course „Naval Architecture and Ocean Engineering” prepares the graduates by solidifying their engineering, mathematical and natural science skills for scientific tasks in naval architecture, ocean engineering and related mechanical engineering disciplines. The graduates possess a critical awareness against new knowledge in their discipline, on which basis they are enabled to act responsible in their professional and societal environment. As a result of the elective modules it is possible to specialize in the following six disciplines: ship design, ship structural design and strength, fluid dynamics, ship machinery, ocean engineering as well as planning and production. Thus, the occupational orientation can either related to the design of ships or offshore systems, or to more dedicated areas, such as hydrodynamics or strength of structures.

Career prospects

The Master course strengthens the engineering, mathematical and natural science knowledge gained during the Bachelor education and conveys competences to solve problems in a systematic, scientific and independent fashion relevant for industry and research activities. The contents concern analysis, design and implementation methods for Ships and Offshore systems. The individual selection of the elective modules allows for a certain specialization while the mandatory courses secure a solid understanding of the general basics and in the related fields. Thereby the students are able to adjust their study contents individually according to their personal preferences. Further, the solid knowledge of the general basics and knowledge in the field related to the chosen specialisation allow for a broad professional expertise and thus a wide professional applicability. The graduates can take on scientific tasks at universities or research institutes with the aim of a doctoral dissertation or find their way directly into the industry. As for the latter, they may specialize in dedicated areas and with further experience and qualification they can take over leading roles.

Learning target

The graduates can analyse problems scientifically and solve them, even though they are not typical or only partially defined with conflicting objectives; complex tasks can be solved by abstracting from on-going research and development activities in their discipline; innovative and new methods can be used to find fundamental solutions; knowledge gaps can be identified and solutions can be proposed to overcome these gaps; theoretical and experimental investigations can be planned and executed; results can be analysed critically and conclusions can be drawn; emerging technologies can be analysed and reviewed. By doing so, they can classify knowledge from different disciplines systematically and thereby cope with complex problems. Further, they are able to reflect on the non-technical aspects of their engineering tasks responsibly. They can expand on the knowledge gained and develop further competences, also with the aim to succeed with a doctoral thesis. Consequently, the key skills from the preceding Bachelor education relevant for practical engineering tasks will be expanded in this Master course.

Program structure

This master course is modularized and follows the university-wide standard course structure with course modules of six credit points. The Master course combines the disciplines relevant for Naval Architecture and Ocean Engineering on the basis of the preceding Bachelor studies. Essential modules are mandatory for all students to allow for an even skill level among graduates. Further, students are able to personalize their studies due to the wide range of module options. The following modules comprise the mandatory core qualification with six credit points each:

- Structural Analysis of Ships and Offshore Structures
- Ship Vibration
    - Ship Safety
    - Seakeeping of Ships and Laboratory on Naval Architecture
    - Maritime Technology and Maritime Systems

The students further specialize by individually selecting six modules from the following options:

- Numerical Methods in Ship Design
- Port Logistics
- High-Order FEM
- Numerical Algorithms in Structural Mechanics
- Computational Fluid Dynamics II
- Computational Structural Dynamics
- Marine Diesel Engine Plants
- Ship propellers and cavitation
- Special topics of ship structural design
- Special Topics of Ship Propulsion and Hydrodynamics of High Speed Water Vehicles
- Selected topics in Naval Architecture and Ocean Engineering (Open module with further topic selection)
- Fatigue Strength of Ships and Offshore Structures
- Arctic Technology
- Innovative CFD Approaches
- Manoeuvrability and Shallow Water Ship Hydrodynamics
- Nonlinear Structural Analysis
- Advanced Ship Design
- Vibration Theory
- Marine Auxiliaries

Additionally, the open module „Business & Management“ and „Nontechnical Elective Complementary Courses for Master“ with six credit points each is mandatory. Finally, in addition to the master thesis, the students must complete a research project:

- Research Project (12 credits)
- Master Thesis (30 credits)

Core Qualification

Module M0523: Business & Management

Module Responsible	Prof. Matthias Meyer
Admission Requirements	None
Recommended Previous Knowledge	None
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students are able to find their way around selected special areas of management within the scope of business management. • Students are able to explain basic theories, categories, and models in selected special areas of business management. • Students are able to interrelate technical and management knowledge.
Skills	• Students are able to apply basic methods in selected areas of business management. • Students are able to explain and give reasons for decision proposals on practical issues in areas of business management.
Personal Competence	
Social Competence	• Students are able to communicate in small interdisciplinary groups and to jointly develop solutions for complex problems
Autonomy	• Students are capable of acquiring necessary knowledge independently by means of research and preparation of material.
Workload in Hours	Depends on choice of courses
Credit points	6

Courses
Information regarding lectures and courses can be found in the corresponding module handbook published separately.

Module M0524: Non-technical Courses for Master

Module Responsible	Dagmar Richter
Admission Requirements	None
Recommended Previous Knowledge	None
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	**The Nontechnical Academic Programms (NTA)** imparts skills that, in view of the TUHH's training profile, professional engineering studies require but are not able to cover fully. Self-reliance, self-management, collaboration and professional and personnel management competences. The department implements these training objectives in its **teaching architecture**, in its **teaching and learning arrangements**, in **teaching areas** and by means of teaching offerings in which students can qualify by opting for **specific competences** and a **competence level** at the Bachelor's or Master's level. The teaching offerings are pooled in two different catalogues for nontechnical complementary courses. **The Learning Architecture** consists of a cross-disciplinarily study offering. The centrally designed teaching offering ensures that courses in the nontechnical academic programms follow the specific profiling of TUHH degree courses. The learning architecture demands and trains independent educational planning as regards the individual development of competences. It also provides orientation knowledge in the form of "profiles". The subjects that can be studied in parallel throughout the student's entire study program - if need be, it can be studied in one to two semesters. In view of the adaptation problems that individuals commonly face in their first semesters after making the transition from school to university and in order to encourage individually planned semesters abroad, there is no obligation to study these subjects in one or two specific semesters during the course of studies. **Teaching and Learning Arrangements** provide for students, separated into B.Sc. and M.Sc., to learn with and from each other across semesters. The challenge of dealing with interdisciplinarity and a variety of stages of learning in courses are part of the learning architecture and are deliberately encouraged in specific courses. **Fields of Teaching** are based on research findings from the academic disciplines cultural studies, social studies, arts, historical studies, communication studies, migration studies and sustainability research, and from engineering didactics. In addition, from the winter semester 2014/15 students on all Bachelor's courses will have the opportunity to learn about business management and start-ups in a goal-oriented way. The fields of teaching are augmented by soft skills offers and a foreign language offer. Here, the focus is on encouraging goal-oriented communication skills, e.g. the skills required by outgoing engineers in international and intercultural situations. **The Competence Level** of the courses offered in this area is different as regards the basic training objective in the Bachelor's and Master's fields. These differences are reflected in the practical examples used, in content topics that refer to different professional application contexts, and in the higher scientific and theoretical level of abstraction in the B.Sc. This is also reflected in the different quality of soft skills, which relate to the different team positions and different group leadership functions of Bachelor's and Master's graduates in their future working life. **Specialized Competence (Knowledge)** Students can • explain specialized areas in context of the relevant non-technical disciplines, • outline basic theories, categories, terminology, models, concepts or artistic techniques in the disciplines represented in the learning area, • different specialist disciplines relate to their own discipline and differentiate it as well as make connections, • sketch the basic outlines of how scientific disciplines, paradigms, models, instruments, methods and forms of representation in the specialized sciences are subject to individual and socio-cultural interpretation and historicity, • Can communicate in a foreign language in a manner appropriate to the subject.
Skills	**Professional Competence (Skills)** In selected sub-areas students can • apply basic and specific methods of the said scientific disciplines, • aquestion a specific technical phenomena, models, theories from the viewpoint of another, aforementioned specialist discipline, • to handle simple and advanced questions in aforementioned scientific disciplines in a sucsessful manner, • justify their decisions on forms of organization and application in practical questions in contexts that go beyond the technical relationship to the subject.

Personal Competence	
Social Competence	**Personal Competences (Social Skills)** Students will be able • to learn to collaborate in different manner, • to present and analyze problems in the abovementioned fields in a partner or group situation in a manner appropriate to the addressees, • to express themselves competently, in a culturally appropriate and gender-sensitive manner in the language of the country (as far as this study-focus would be chosen), • to explain nontechnical items to auditorium with technical background knowledge.
Autonomy	**Personal Competences (Self-reliance)** Students are able in selected areas • to reflect on their own profession and professionalism in the context of real-life fields of application • to organize themselves and their own learning processes • to reflect and decide questions in front of a broad education background • to communicate a nontechnical item in a competent way in writen form or verbaly • to organize themselves as an entrepreneurial subject country (as far as this study-focus would be chosen)
Workload in Hours	Depends on choice of courses
Credit points	6

Courses
Information regarding lectures and courses can be found in the corresponding module handbook published separately.

Module M1233: Numerical Methods in Ship Design

Courses

Title	Typ	Hrs/wk	CP
Numerical Methods in Ship Design (L1271)	Lecture	2	4
Numerical Methods in Ship Design (L1709)	Project-/problem-based Learning	2	2

Module Responsible	Prof. Stefan Krüger
Admission Requirements	None
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	
Skills	
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	45 min
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L1271: Numerical Methods in Ship Design

Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	SoSe
Content	The lecture starts with the definition of the early design phase and the importance of first principle approaches. The reasons for process reengineering when such kinds of methods are introduced is demonstrated. Several numerical modelling techniques are introduced and discussed for the following design relevant topics: - Hullform representation, fairing and interpolation - Hullform design by modifying parent hulls - Modelling of subdivison - Volumetric and stability calculations - Mass distributions and longitudinal strength - Hullform Design by CFD- techniques - Propulsor and Rudder Design by CFD Techniques
Literature	Skript zur Vorlesung.

Course L1709: Numerical Methods in Ship Design

Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0601: Structural Analysis of Ships and Offshore Structures

Courses

Title	Typ	Hrs/wk	CP
Structural Analysis of Ships and Offshore Structures (L0272)	Lecture	2	3
Structural Analysis of Ships and Offshore Structures (L0273)	Recitation Section (small)	2	3

Module Responsible	Prof. Alexander Düster
Admission Requirements	None
Recommended Previous Knowledge	Mathematics I, II, III, Mechanics I, II, III, IV Differential Equations 2 (Partial Differential Equations)
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to + 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.
Skills	Students are able to + model linear structural problems of ships and offshore structures. + select a suitable finite element formulation for a given linear problem of structural mechanics . + apply finite element procedures to the linear structural analysis of ships and offshore structures. + verify and critically judge the results of linear finite element computations. + transfer their knowledge of linear structural analysis with finite elements to new problems.
Personal Competence	
Social Competence	Students are able to + solve problems in heterogeneous groups and to document the corresponding results. + share new knowledge with group members.
Autonomy	Students are able to + assess their knowledge by means of exercises and E-Learning.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	2h
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Compulsory Ship and Offshore Technology: Core Qualification: Compulsory

Course L0272: Structural Analysis of Ships and Offshore Structures

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Düster
Language	DE/EN
Cycle	WiSe
Content	1. Introduction 2. Basic equations of elastostatics 3. Approximation procedures 4. The finite element method 5. Mechanical models and finite elements for thin-walled structures 6. Application to ships and offshore structures
Literature	[1] Alexander Düster, Structural Analysis of Ships and Offshore Structures, Lecture Notes, Technische Universität Hamburg-Harburg, 125 pages, 2014. [2] G. Clauss, E. Lehmann, C. Östergaard, M.J. Shields, Offshore Structures: Volume II, Strength and Safety for Structural Design, Springer, 1993. [3] G. Clauss, E. Lehmann, C. Östergaard, Meerestechnische Konstruktionen, Springer, 1988.

Course L0273: Structural Analysis of Ships and Offshore Structures	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Düster
Language	DE/EN
Cycle	WiSe
Content	1. Introduction 2. Basic equations of elastostatics 3. Approximation procedures 4. The finite element method 5. Mechanical models and finite elements for thin-walled structures 6. Application to ships and offshore structures
Literature	[1] Alexander Düster, Structural Analysis of Ships and Offshore Structures, Lecture Notes, Technische Universität Hamburg-Harburg, 125 pages, 2014. [2] G. Clauss, E. Lehmann, C. Östergaard, M.J. Shields, Offshore Structures: Volume II, Strength and Safety for Structural Design, Springer, 1993. [3] G. Clauss, E. Lehmann, C. Östergaard, Meerestechnische Konstruktionen, Springer, 1988.

Module M1146: Ship Vibration

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Ship Vibration (L1528)	Lecture	2	3
Ship Vibration (L1529)	Recitation Section (small)	2	3

Module Responsible	Dr. Rüdiger Ulrich Franz von Bock und Polach
Admission Requirements	None
Recommended Previous Knowledge	Mechanis I - III Structural Analysis of Ships I Fundamentals of Ship Structural Design
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can reproduce the acceptance criteria for vibrations on ships; they can explain the methods for the calculation of natural frequencies and forced vibrations of sructural components and the entire hull girder; they understand the effect of exciting forces of the propeller and main engine and methods for their determination
Skills	Students are capable to apply methods for the calculation of natural frequencies and exciting forces and resulting vibrations of ship structures including their assessment; they can model structures for the vibration analysis
Personal Competence	
Social Competence	The students are able to communicate and cooperate in a professional environment in the shipbuilding and component supply industry.
Autonomy	Students are able to detect vibration-prone components on ships, to model the structure, to select suitable calculation methods and to assess the results
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	3 hours
Assignment for the Following Curricula	Energy Systems: Specialisation Marine Engineering: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Compulsory Ship and Offshore Technology: Core Qualification: Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L1528: Ship Vibration

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Rüdiger Ulrich Franz von Bock und Polach
Language	EN
Cycle	WiSe
Content	1. Introduction; assessment of vibrations 2. Basic equations 3. Beams with discrete / distributed masses 4. Complex beam systems 5. Vibration of plates and Grillages 6. Deformation method / practical hints / measurements 7. Hydrodynamic masses 8. Spectral method 9. Hydrodynamic masses acc. to Lewis 10. Damping 11. Shaft systems 12. Propeller excitation 13. Engines
Literature	Siehe Vorlesungsskript

Course L1529: Ship Vibration	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Rüdiger Ulrich Franz von Bock und Polach
Language	EN
Cycle	WiSe
Content	1. Introduction; assessment of vibrations 2. Basic equations 3. Beams with discrete / distributed masses 4. Complex beam systems 5. Vibration of plates and Grillages 6. Deformation method / practical hints / measurements 7. Hydrodynamic masses 8. Spectral method 9. Hydrodynamic masses acc. to Lewis 10. Damping 11. Shaft systems 12. Propeller excitation 13. Engines
Literature	Siehe Vorlesungsskript

Module M1165: Ship Safety

Courses

Title	Typ	Hrs/wk	CP
Ship Safety (L1267)	Lecture	2	4
Ship Safety (L1268)	Recitation Section (large)	2	2

Module Responsible	Prof. Stefan Krüger
Admission Requirements	None
Recommended Previous Knowledge	Ship Design, Hydrostatics, Statistical Processes
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The student shall lean to integrate safety aspects into the ship design process. This includes the undertsnding and application of existing rules as well as the understanding of the sfatey concept and level which is targeted by a rule. Further, methods of demonstrating equivalent safety levels are introduced.
Skills	he lectures starts with an overview about general safety concepts for technical systems. The maritime safety organizations are introduced, their responses and duties. Then, the gerenal difference between prescriptive and performance based rules is tackled. Foer different examples in ship design, the influence of the rules on the deign is illustrated . Further, limitations of saftey rules with respect to the physical background are shown. Concepts of demonstrating equivalent levels of safety by direct calculations are discussed. The following fields will be treated. - Freeboard, water- and weathertight subdivisions, openings - all aspects of intact stability, including special problems such as grain code - damage stability for passenger vessels including Stockholm agreement - damage stbility fopr cargo vessels - on board stability, inclining experiment and stability booklet - Relevant manoevering information
Personal Competence	
Social Competence	The student learns to take responsibilty for the safety of his designn.
Autonomy	Responsible certification of technical designs.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	180 min
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L1267: Ship Safety

Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	WiSe
Content	The lectures starts with an overview about general safety concepts for technical systems. The maritime safety organizations are introduced, their responses and duties. Then, the gerenal difference between prescriptive and performance based rules is tackled. Foer different examples in ship design, the influence of the rules on the deign is illustrated . Further, limitations of saftey rules with respect to the physical background are shown. Concepts of demonstrating equivalent levels of safety by direct calculations are discussed. The following fields will be treated. - Freeboard, water- and weathertight subdivisions, openings - all aspects of intact stability, including special problems such as grain code - damage stability for passenger vessels including Stockholm agreement - damage stbility fopr cargo vessels - on board stability, inclining experiment and stability booklet - Relevant manoevering information
Literature	SOLAS, LOAD LINES, CODE ON INTACT STABILITY. Alle IMO, London.

Course L1268: Ship Safety	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1176: Seakeeping of Ships and Laboratory on Naval Architecture

Courses

Title	Typ	Hrs/wk	CP
Laboratory on Naval Architecture (L0241)	Practical Course	2	2
Seakeeping of Ships (L1594)	Lecture	2	3
Seakeeping of Ships (L1619)	Recitation Section (small)	2	1

Module Responsible	Prof. Moustafa Abdel-Maksoud
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge of ship dynamics as well as stochastic and statistics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Understand present research questions in the field of ship motion in waves • Explain the present state of the art for the topics considered • Apply given methodology to approach given problems of seakeeping behavior • Evaluate the limits of the present methods • Identify possibilities to extend present methods • Evaluate the feasibility of further developments
Skills	Students are able to • select and apply suitable computing and simulation methods to determine the dynamic loads on ships and floating bodies • model the behavior of ships and floating bodies under different sea conditions by using simplified methods • evaluate critically the investigation results of experimental or numerical studies
Personal Competence	
Social Competence	Students are able to • solve problems in heterogeneous groups and to document the corresponding results • share new knowledge with group members
Autonomy	Students are able to • assess their knowledge by means of exercises • think system-oriented • decompose complex systems
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	**Compulsory** Yes; **Bonus** 20 %; **Form** Excercises; **Description**
Examination	Written exam
Examination duration and scale	180 min
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Compulsory Ship and Offshore Technology: Core Qualification: Elective Compulsory

Course L0241: Laboratory on Naval Architecture	
Typ	Practical Course
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Thomas Rung, M.Sc. Hauke Herrnring
Language	DE/EN
Cycle	SoSe
Content	The lab is structured into 5 team-based experiments 1. Resistance test Towing test to investigate a model hull resistance 2. Propulsion test Propulsion fest for a self propelled hulll. Determination of thrust deduction, wake fraction and propulsion efficiency. 3. Seakeeping test Investigation of the seakeeping behaviour 4. Open water and cavitation test Compilation of an open water diagram and cavitation experiments 5. Application of strain measurement techniques Theoretical instructions will also involve foundations of similarity analysis
Literature	Vorlesungsmanuskript Lecture Notes

Course L1594: Seakeeping of Ships	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Moustafa Abdel-Maksoud
Language	DE/EN
Cycle	WiSe
Content	1. Numerical methods for the determination of section forces 2. Steep waves (Stokes-Theory) 3. 3d-potential flow methods 4. Time domain simulaiton of ship motions 5. Capsizing 6. Slamming
Literature	• Söding, H., Schiffe im Seegang I, Vorlesungsmanuskript, Institut für Fluiddynamik und Schiffstheorie, TUHH, Hamburg, 1992 • Jensen, G., Söding, H. S., Schiffe im Seegang II, Vorlesungsmanuskript, Institut für Fluiddynamik und Schiffstheorie, TUHH, Hamburg, 2005 • Bertram, V., Practical Ship Design Hydrodynamics, Butterworth-Heinemann, Linacre House, Jordan Hill, Oxford, United Kingdom, 2000 • Lloyed, A., Ship Behaviour in Rough Weather, Gosport, Chichester, Sussex, United Kingdom, 1998 • Jensen, J. J., Load and Global Response of Ships, Elsevier Science, Oxford, United Kingdom, 2001

Course L1619: Seakeeping of Ships	
Typ	Recitation Section (small)
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Prof. Moustafa Abdel-Maksoud
Language	DE/EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1177: Maritime Technology and Maritime Systems

Courses

Title	**Typ**	**Hrs/wk**	**CP**
Analysis of Maritime Systems (L0068)	Lecture	2	2
Analysis of Maritime Systems (L0069)	Recitation Section (small)	1	1
Introduction to Maritime Technology (L0070)	Lecture	2	2
Introduction to Maritime Technology (L1614)	Recitation Section (small)	1	1

Module Responsible	Prof. Moustafa Abdel-Maksoud
Admission Requirements	None
Recommended Previous Knowledge	Solid knowledge and competences in mechanics, fluid dynamics and analysis (series, periodic functions, continuity, differentiability, integration, multiple variables, ordinaray and partial differential equations, boundary value problems, initial conditions and eigenvalue problems).
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After successful completion of this class, students should have an overview about phenomena and methods in ocean engineering and the ability to apply and extend the methods presented. In detail, the students should be able to • describe the different aspects and topics in Maritime Technology, • apply existing methods to problems in Maritime Technology, • discuss limitations in present day approaches and perspectives in the future, • Techniques for the analysis of offshore systems, • Modeling and evaluation of dynamic systems, • System-oriented thinking, decomposition of complex systems.
Skills	The students learn the ability of apply and transfer existing methods and techniques on novel questions in maritime technologies. Furthermore, limits of the existing knowledge and future developments will be discussed.
Personal Competence	
Social Competence	The processing of an exercise in a group of up to four students shall strengthen the communication and team-working skills and thus promote an important working technicque of subsequent working days. The collaboration has to be illustrated in a community presentation of the results.
Autonomy	The course contents are absorbed in an exercise work in a group and individually checked in a final exam in which a self-reflection of the learned is expected without tools.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	180 min
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L0068: Analysis of Maritime Systems	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Moustafa Abdel-Maksoud, Dr. Alexander Mitzlaff
Language	DE
Cycle	SoSe
Content	1. Hydrostatic analysis ◦ Buoyancy, ◦ Stability, 2. Hydrodynamic analysis ◦ Froude-Krylov force ◦ Morison's equation, ◦ Radiation and diffraction ◦ transparent/compact structures 3. Evaluation of offshore structures: Reliability techniques (security, reliability, disposability) ◦ Short-term statistics ◦ Long-term statistics and extreme events
Literature	• G. Clauss, E. Lehmann, C. Östergaard. Offshore Structures Volume I: Conceptual Design and Hydrodynamics. Springer Verlag Berlin, 1992 • E. V. Lewis (Editor), Principles of Naval Architecture ,SNAME, 1988 • Journal of Offshore Mechanics and Arctic Engineering • Proceedings of International Conference on Offshore Mechanics and Arctic Engineering • S. Chakrabarti (Ed.), Handbook of Offshore Engineering, Volumes 1-2, Elsevier, 2005 • S. K. Chakrabarti, Hydrodynamics of Offshore Structures , WIT Press, 2001

Course L0069: Analysis of Maritime Systems	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Moustafa Abdel-Maksoud, Dr. Alexander Mitzlaff
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0070: Introduction to Maritime Technology	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Walter Kuehnlein, Dr. Sven Hoog
Language	DE
Cycle	WiSe
Content	1. Introduction • Ocean Engineering and Marine Research • The potentials of the seas • Industries and occupational structures 2. Coastal and offshore Environmental Conditions • Physical and chemical properties of sea water and sea ice • Flows, waves, wind, ice • Biosphere 3. Response behavior of Technical Structures 4. Maritime Systems and Technologies • General Design and Installation of Offshore-Structures • Geophysical and Geotechnical Aspects • Fixed and Floating Platforms • Mooring Systems, Risers, Pipelines • Energy conversion: Wind, Waves, Tides
Literature	• Chakrabarti, S., Handbook of Offshore Engineering, vol. I/II, Elsevier 2005. • Gerwick, B.C., Construction of Marine and Offshore Structures, CRC-Press 1999. • Wagner, P., Meerestechnik, Ernst&Sohn 1990. • Clauss, G., Meerestechnische Konstruktionen, Springer 1988. • Knauss, J.A., Introduction to Physical Oceanography, Waveland 2005. • Wright, J. et al., Waves, Tides and Shallow-Water Processes, Butterworth 2006. • Faltinsen, O.M., Sea Loads on Ships and Offshore Structures, Cambridge 1999.

Course L1614: Introduction to Maritime Technology	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Walter Kuehnlein
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1234: Ship propellers and cavitation

Courses

Title	**Typ**	**Hrs/wk**	**CP**
Cavitation (L1596)	Lecture	2	3
Marine Propellers (L1270)	Project-/problem-based Learning	2	1
Marine Propellers (L1269)	Lecture	2	2

Module Responsible	Prof. Stefan Krüger
Admission Requirements	None
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	
Skills	
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	45 min
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory

Course L1596: Cavitation

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Moustafa Abdel-Maksoud
Language	DE
Cycle	SoSe
Content	• Phenomenon and type of cavitation • Test facilities and instrumentations • Dynamics of bubbles • Bubbles cavitation • Supercavitation • Ventilated supercavities • Vortex cavitation • Sheet cavitation • Cavitation in rotary machines • Numerical cavitation models I • Numerical cavitation models II • Pressure fluctuation • Erosion and noise
Literature	• Lewis, V. E. (Ed.) , Principles of Naval Architecture, Resistance Propulsion, Vibration, Volume II, Controllability, SNAME, New York, 1989. • Isay, W. H., Kavitation, Schiffahrt-Verlag Hansa, Hamburg, 1989. • Franc, J.-P., Michel, J.-M. Fundamentals of Cavitation, Kluwer Academic Publisher, 2004. • Lecoffre, Y., Cavitation Bubble Trackers, Balkema / Rotterdam / Brookfield, 1999. • Brennen, C. E., Cavitation and Bubble Dynamics, Oxford University Press, 1995.

Course L1270: Marine Propellers	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	SoSe
Content	The lectures starts with the description of the propeller blade outline parameters. The design fundamantals for the blade parameters are introduced. The momentum theory for screw propellers is treated. The design optimization of the propeller by means of systematic propeller series is considered. The lecture then treats the profile theory of the airfoil with infinite span (singularity methods) for the most common technical profiles. Lifting line theory is introduced as calculation tool for radial circulation distribution. The lecture continues with the interaction propeller and main propulsion plant. Strategies to control a CPP are discussed. The lecture closes with the most important cavitation phenemena which are relevant for the determination of pressure fluctuations.
Literature	W.H. Isay, Propellertheorie. Springer Verlag.

Course L1269: Marine Propellers	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	SoSe
Content	The lectures starts with the description of the propeller blade outline parameters. The design fundamantals for the blade parameters are introduced. The momentum theory for screw propellers is treated. The design optimization of the propeller by means of systematic propeller series is considered. The lecture then treats the profile theory of the airfoil with infinite span (singularity methods) for the most common technical profiles. Lifting line theory is introduced as calculation tool for radial circulation distribution. The lecture continues with the interaction propeller and main propulsion plant. Strategies to control a CPP are discussed. The lecture closes with the most important cavitation phenemena which are relevant for the determination of pressure fluctuations.
Literature	W.H. Isay, Propellertheorie. Springer Verlag.

Module M0604: High-Order FEM

Courses

Title	Typ	Hrs/wk	CP
High-Order FEM (L0280)	Lecture	3	4
High-Order FEM (L0281)	Recitation Section (large)	1	2

Module Responsible	Prof. Alexander Düster
Admission Requirements	None
Recommended Previous Knowledge	Knowledge of partial differential equations is recommended.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to + give an overview of the different (h, p, hp) finite element procedures. + explain high-order finite element procedures. + specify problems of finite element procedures, to identify them in a given situation and to explain their mathematical and mechanical background.
Skills	Students are able to + apply high-order finite elements to problems of structural mechanics. + select for a given problem of structural mechanics a suitable finite element procedure. + critically judge results of high-order finite elements. + transfer their knowledge of high-order finite elements to new problems.
Personal Competence	
Social Competence	Students are able to + solve problems in heterogeneous groups. + present and discuss their results in front of others. + give and accept professional constructive criticism.
Autonomy	Students are able to + assess their knowledge by means of exercises and E-Learning. + acquaint themselves with the necessary knowledge to solve research oriented tasks. + to transform the acquired knowledge to similar problems.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	**Compulsory** No; **Bonus** 10 %; **Form** Presentation; **Description** Forschendes Lernen
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	Energy Systems: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Materials Science: Specialisation Modeling: Elective Compulsory Mechanical Engineering and Management: Specialisation Product Development and Production: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory

Course L0280: High-Order FEM	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Alexander Düster
Language	EN
Cycle	SoSe
Content	1. Introduction 2. Motivation 3. Hierarchic shape functions 4. Mapping functions 5. Computation of element matrices, assembly, constraint enforcement and solution 6. Convergence characteristics 7. Mechanical models and finite elements for thin-walled structures 8. Computation of thin-walled structures 9. Error estimation and hp-adaptivity 10. High-order fictitious domain methods
Literature	[1] Alexander Düster, High-Order FEM, Lecture Notes, Technische Universität Hamburg-Harburg, 164 pages, 2014 [2] Barna Szabo, Ivo Babuska, Introduction to Finite Element Analysis – Formulation, Verification and Validation, John Wiley & Sons, 2011

Course L0281: High-Order FEM	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Alexander Düster
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0605: Computational Structural Dynamics

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Computational Structural Dynamics (L0282)	Lecture	3	4
Computational Structural Dynamics (L0283)	Recitation Section (small)	1	2

Module Responsible	Prof. Alexander Düster
Admission Requirements	None
Recommended Previous Knowledge	Knowledge of partial differential equations is recommended.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to + give an overview of the computational procedures for problems of structural dynamics. + explain the application of finite element programs to solve problems of structural dynamics. + specify problems of computational structural dynamics, to identify them in a given situation and to explain their mathematical and mechanical background.
Skills	Students are able to + model problems of structural dynamics. + select a suitable solution procedure for a given problem of structural dynamics. + apply computational procedures to solve problems of structural dynamics. + verify and critically judge results of computational structural dynamics.
Personal Competence	
Social Competence	Students are able to + solve problems in heterogeneous groups. + present and discuss their results in front of others. + give and accept professional constructive criticism.
Autonomy	Students are able to + assess their knowledge by means of exercises and E-Learning. + acquaint themselves with the necessary knowledge to solve research oriented tasks. + to transform the acquired knowledge to similar problems.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	2h
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Materials Science: Specialisation Modeling: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory

Course L0282: Computational Structural Dynamics

Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Alexander Düster
Language	DE
Cycle	SoSe
Content	1. Motivation 2. Basics of dynamics 3. Time integration methods 4. Modal analysis 5. Fourier transform 6. Applications
Literature	[1] K.-J. Bathe, Finite-Elemente-Methoden, Springer, 2002. [2] J.L. Humar, Dynamics of Structures, Taylor & Francis, 2012.

Course L0283: Computational Structural Dynamics	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Alexander Düster
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0606: Numerical Algorithms in Structural Mechanics

Courses

Title	Typ	Hrs/wk	CP
Numerical Algorithms in Structural Mechanics (L0284)	Lecture	2	3
Numerical Algorithms in Structural Mechanics (L0285)	Recitation Section (small)	2	3

Module Responsible	Prof. Alexander Düster
Admission Requirements	None
Recommended Previous Knowledge	Knowledge of partial differential equations is recommended.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to + give an overview of the standard algorithms that are used in finite element programs. + explain the structure and algorithm of finite element programs. + specify problems of numerical algorithms, to identify them in a given situation and to explain their mathematical and computer science background.
Skills	Students are able to + construct algorithms for given numerical methods. + select for a given problem of structural mechanics a suitable algorithm. + apply numerical algorithms to solve problems of structural mechanics. + implement algorithms in a high-level programming languate (here C++). + critically judge and verfiy numerical algorithms.
Personal Competence	
Social Competence	Students are able to + solve problems in heterogeneous groups. + present and discuss their results in front of others. + give and accept professional constructive criticism.
Autonomy	Students are able to + assess their knowledge by means of exercises and E-Learning. + acquaint themselves with the necessary knowledge to solve research oriented tasks. + to transform the acquired knowledge to similar problems.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	2h
Assignment for the Following Curricula	Materials Science: Specialisation Modeling: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory

Course L0284: Numerical Algorithms in Structural Mechanics

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Düster
Language	DE
Cycle	SoSe
Content	1. Motivation 2. Basics of C++ 3. Numerical integration 4. Solution of nonlinear problems 5. Solution of linear equation systems 6. Verification of numerical algorithms 7. Selected algorithms and data structures of a finite element code
Literature	[1] D. Yang, C++ and object-oriented numeric computing, Springer, 2001. [2] K.-J. Bathe, Finite-Elemente-Methoden, Springer, 2002.

Course L0285: Numerical Algorithms in Structural Mechanics	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Düster
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0657: Computational Fluid Dynamics II

Courses

Title	Typ	Hrs/wk	CP
Computational Fluid Dynamics II (L0237)	Lecture	2	3
Computational Fluid Dynamics II (L0421)	Recitation Section (large)	2	3

Module Responsible	Prof. Thomas Rung
Admission Requirements	None
Recommended Previous Knowledge	Students should have sound knowledge of engineering mathematics (series expansions, internal & vector calculus), and be familiar with the foundations of partial/ordinary differential equations. They should also be familiar with engineering fluid mechanics and thermodynamics. Basic knowledge of numerical analysis or computational fluid dynamics is of advantage but not necessary.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students will acquire a deeper knowledge of computational fluid dynamics (CFD) and can translate general principles of thermo-/fluid engineering into discrete algorithms on the basis of finite volume methods. They are familiar with the similarities and differences between different discretisation and approximation concepts for investigating coupled systems of non-linear, convective partial differential equations (PDE) on structured and unstructured grids. Students have the required background knowledge to develop, code and apply modelling concepts to numerically describe turbulent and multiphase flow. They establish a thorough understanding of details of the theoretical background of complex CFD algorithms and the parameters used to control and adjust the execution of CFD procedures.
Skills	The students are able choose and apply appropriate finite volume (FV) approximation concepts and flow physics models that integrate the governing thermofluid dynamic PDEs in space and time. They can apply/optimise FV concepts to/for fluid dynamic applications. They acquire the ability to code computational algorithms dedicated to unstructured grid arrangements, apply these codes for parameter investigations and supplement interfaces to extract simulation data for an engineering analysis. They are able to judge different solution strategies.
Personal Competence	
Social Competence	The students are able to discuss problems, present the results of their own analysis, and jointly develop, implement and report on solution strategies that address given technical reference problems in a team.
Autonomy	The students can independently analyse numerical methods to solving fluid engineering problems. They are able to critically analyse own results as well as external data with regards to the plausibility and reliability.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	0.5h-0.75h
Assignment for the Following Curricula	Energy Systems: Core Qualification: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0237: Computational Fluid Dynamics II

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Thomas Rung
Language	DE/EN
Cycle	SoSe
Content	Computational Modelling of complex single- and multiphase flows using higher-order approximations for unstructured grids and mehsless particle-based methods.
Literature	1) Vorlesungsmanuskript und Übungsunterlagen 2) J.H. Ferziger, M. Peric: Computational Methods for Fluid Dynamics, Springer

Course L0421: Computational Fluid Dynamics II	
Typ	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Thomas Rung
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1021: Marine Diesel Engine Plants

Courses

Title	Typ	Hrs/wk	CP
Marine Diesel Engine Plants (L0637)	Lecture	3	4
Marine Diesel Engine Plants (L0638)	Recitation Section (large)	1	2

Module Responsible	Prof. Christopher Friedrich Wirz
Admission Requirements	None
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can • explain different types four / two-stroke engines and assign types to given engines, • name definitions and characteristics, as well as • elaborate on special features of the heavy oil operation, lubrication and cooling.
Skills	Students can • evaluate the interaction of ship, engine and propeller, • use relationships between gas exchange, flushing, air demand, charge injection and combustion for the design of systems, • design waste heat recovery, starting systems, controls, automation, foundation and design machinery spaces , and • apply evaluation methods for excited motor noise and vibration.
Personal Competence	
Social Competence	The students are able to communicate and cooperate in a professional environment in the shipbuilding and component supply industry.
Autonomy	The widespread scope of gained knowledge enables the students to handle situations in their future profession independently and confidently.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	20 min
Assignment for the Following Curricula	Energy Systems: Specialisation Energy Systems: Elective Compulsory Energy Systems: Specialisation Marine Engineering: Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L0637: Marine Diesel Engine Plants	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Christopher Friedrich Wirz
Language	DE
Cycle	SoSe
Content	• Historischer Überblick • Bauarten von Vier- und Zweitaktmotoren als Schiffsmotoren • Vergleichsprozesse, Definitionen, Kenndaten • Zusammenwirken von Schiff, Motor und Propeller • Ausgeführte Schiffsdieselmotoren • Gaswechsel, Spülverfahren, Luftbedarf • Aufladung von Schiffsdieselmotoren • Einspritzung und Verbrennung • Schwerölbetrieb • Schmierung • Kühlung • Wärmebilanz • Abwärmenutzung • Anlassen und Umsteuern • Regelung, Automatisierung, Überwachung • Motorerregte Geräusche und Schwingungen • Fundamentierung • Gestaltung von Maschinenräumen
Literature	• D. Woodyard: Pounder's Marine Diesel Engines • H. Meyer-Peter, F. Bernhardt: Handbuch der Schiffsbetriebstechnik • K. Kuiken: Diesel Engines • Mollenhauer, Tschöke: Handbuch Dieselmotoren • Projektierungsunterlagen der Motorenhersteller

Course L0638: Marine Diesel Engine Plants	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Christopher Friedrich Wirz
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1133: Port Logistics

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Port Logistics (L0686)	Lecture	2	3
Port Logistics (L1473)	Recitation Section (small)	2	3

Module Responsible	Prof. Carlos Jahn
Admission Requirements	None
Recommended Previous Knowledge	none
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Th After completing the module, students can... • reflect on the development of seaports (in terms of the functions of the ports and the corresponding terminals, as well as the relevant operator models) and place them in their historical context; • explain and evaluate different types of seaport terminals and their specific characteristics (cargo, transhipment technologies, logistic functional areas); • analyze common planning tasks (e.g. berth planning, stowage planning, yard planning) at seaport terminals and develop suitable approaches (in terms of methods and tools) to solve these planning tasks; • identify future developments and trends regarding the planning and control of innovative seaport terminals and discuss them in a problem-oriented manner.
Skills	After completing the module, students will be able to... • recognize functional areas in ports and seaport terminals; • define and evaluate suitable operating systems for container terminals; • perform static calculations with regard to given boundary conditions, e.g. required capacity (parking spaces, equipment requirements, quay wall length, port access) on selected terminal types; • reliably estimate which boundary conditions influence common logistics indicators in the static planning of selected terminal types and to what extent.
Personal Competence	
Social Competence	After completing the module, students can... • transfer the acquired knowledge to further questions of port logistics; • discuss and successfully organize extensive task packages in small groups; • in small groups, document work results in writing in an understandable form and present them to an appropriate extent.
Autonomy	After completing the module, the students are able to... • research and select specialist literature, including standards, guidelines and journal papers, and to develop the contents independently; • submit own parts in an extensive written elaboration in small groups in due time and to present them jointly within a fixed time frame.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	**Compulsory** / **Bonus** / **Form** / **Description** No / 15 % / Written elaboration /
Examination	Written exam
Examination duration and scale	120 minutes
Assignment for the Following Curricula	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Logistics: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compulsory Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L0686: Port Logistics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Carlos Jahn
Language	DE
Cycle	SoSe
Content	Port Logistics deals with the planning, control, execution and monitoring of material flows and the associated information flows in the port system and its interfaces to numerous actors inside and outside the port area. The extraordinary role of maritime transport in international trade requires very efficient ports. These must meet numerous requirements in terms of economy, speed, safety and the environment. Against this background, the lecture Port Logistics deals with the planning, control, execution and monitoring of material flows and the associated information flows in the port system and its interfaces to numerous actors inside and outside the port area. The aim of the lecture Port Logistics is to convey an understanding of structures and processes in ports. The focus will be on different types of terminals, their characteristical layouts and the technical equipment used as well as the ongoing digitization and interaction of the players involved. In addition, renowned guest speakers from science and practice will be regularly invited to discuss some lecture-relevant topics from alternative perspectives. The following contents will be conveyed in the lectures: • Instruction of structures and processes in the port • Planning, control, implementation and monitoring of material and information flows in the port • Fundamentals of different terminals, characteristical layouts and the technical equipment used • Handling of current issues in port logistics
Literature	• Alderton, Patrick (2013). Port Management and Operations. • Biebig, Peter and Althof, Wolfgang and Wagener, Norbert (2017). Seeverkehrswirtschaft: Kompendium. • Brinkmann, Birgitt. Seehäfen: Planung und Entwurf. Berlin Heidelberg: Springer-Verlag, 2005. • Büter, Clemens (2013). Außenhandel: Grundlagen internationaler Handelsbeziehungen. • Gleissner, Harald and Femerling, J. Christian (2012). Logistik: Grundlagen, Übungen, Fallbeispiele. • Jahn, Carlos; Saxe, Sebastian (Hg.). Digitalization of Seaports - Visions of the Future, Stuttgart: Fraunhofer Verlag, 2017. • Kummer, Sebastian (2019). Einführung in die Verkehrswirtschaft • Lun, Y.H.V. and Lai, K.-H. and Cheng, T.C.E. (2010). Shipping and Logistics Management. • Woitschützke, Claus-Peter (2013). Verkehrsgeografie.

Course L1473: Port Logistics	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Carlos Jahn
Language	DE
Cycle	SoSe
Content	The content of the exercise is the independent preparation of a scientific paper plus an accompanying presentation on a current topic of port logistics. The paper deals with current topics of port logistics. For example, the future challenges in sustainability and productivity of ports, the digital transformation of terminals and ports or the introduction of new regulations by the International Maritime Organization regarding the verified gross weight of containers. Due to the international orientation of the event, the paper is to be prepared in English.
Literature	• Alderton, Patrick (2013). Port Management and Operations. • Biebig, Peter and Althof, Wolfgang and Wagener, Norbert (2017). Seeverkehrswirtschaft: Kompendium. • Brinkmann, Birgitt. Seehäfen: Planung und Entwurf. (2005) Berlin Heidelberg: Springer-Verlag. • Büter, Clemens (2013). Außenhandel: Grundlagen internationaler Handelsbeziehungen. • Gleissner, Harald and Femerling, J. Christian (2012). Logistik: Grundlagen, Übungen, Fallbeispiele. • Jahn, Carlos; Saxe, Sebastian (Hg.) (2017) Digitalization of Seaports - Visions of the Future, Stuttgart: Fraunhofer Verlag. • Kummer, Sebastian (2019). Einführung in die Verkehrswirtschaft • Lun, Y.H.V. and Lai, K.-H. and Cheng, T.C.E. (2010). Shipping and Logistics Management. • Woitschützke, Claus-Peter (2013). Verkehrsgeografie.

Module M1148: Selected topics in Naval Architecture and Ocean Engineering

Courses

Title	Typ	Hrs/wk	CP
Outfitting and Operation of Special Purpose Offshore Ships (L1896)	Lecture	2	3
Design of Underwater Vessels (L0670)	Lecture	2	3
Lattice-Boltzmann methods for the simulation of free surface flows (L2066)	Lecture	2	3
Machine Learning and Dynamics of Maritime Systems I (L2855)	Project-/problem-based Learning	3	3
Machine Learning and Dynamics of Maritime Systems II (L2856)	Project-/problem-based Learning	3	3
Modeling and Simulation of Maritime Systems (L2013)	Project-/problem-based Learning	2	3
Offshore Wind Parks (L0072)	Lecture	2	3
Ship Acoustics (L1605)	Lecture	2	3
Ship Dynamics (L0352)	Lecture	2	3
Selected Topics of Experimental and Theoretical Fluiddynamics (L0240)	Lecture	2	3
Technical Elements and Fluid Mechanics of Sailing Ships (L0873)	Lecture	2	3
Technology of Naval Surface Vessels (L0765)	Lecture	2	3

Module Responsible	Prof. Sören Ehlers
Admission Requirements	None
Recommended Previous Knowledge	none
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students are able to find their way through selected special areas within naval architecture and ocean engineering • Students are able to explain basic models and procedures in selected special areas. • Students are able to interrelate scientific and technical knowledge.
Skills	Students are able to apply basic methods in selected areas of ship and ocean engineering.
Personal Competence	
Social Competence	The students are able to communicate and cooperate in a professional environment in the shipbuilding and component supply industry.
Autonomy	Students can chose independently, in which fields they want to deepen their knowledge and skills through the election of courses.
Workload in Hours	Depends on choice of courses
Credit points	6
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L1896: Outfitting and Operation of Special Purpose Offshore Ships	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Hendrik Vorhölter
Language	DE
Cycle	SoSe
Content	The lecture is separated into two parts. In the first part some basic skills necessary for the design of offshore vessels and their equipment will be repeated and where necessary deepened. In particular, the specialties which are common for the ma-jority of offshore vessels will be addressed: rules and regulations, determination of operational limits as well as mooring and dynamic positioning. In the second part of the lecture single types of special offshore vessels and their equipment and outfitting will be addressed. For each type the specific requirements on design and operation will be discussed. Furthermore, the students shall be en-gaged with the preparation of short presentation about the specific ship types as incentive for the respective unit. In particular, it is planned to discuss the following ship types in the lecture: - Anchor handling and plattform supply vessels - Cable -and pile lay vessels - Jack-up vessels - Heavy lift and offshore construction vessels - Dredgers and rock dumping vessels - Diving support vessels
Literature	Chakrabarti, S. (2005): Handbook of Offshore Engineering. Elsevier. Amsterdam, London Volker Patzold (2008): Der Nassabbau. Springer. Berlin Milwee, W. (1996): Modern Marine Salvage. Md Cornell Maritime Press. Centreville. DNVGL-ST-N001 „Marine Operations and Marin Warranty“ IMCA M 103 “The Design and Operation of Dynamically Positioned Vessels” 2007-12 IMCA M 182 “The Safe Operation of Dynamically Positioned Offshore Supply Vessels” 2006-03 IMCA M 187 “Lifting Operations” 2007-10 IMCA SEL 185 “Transfer of Personnel to and from Offshore Vessels” 2010-03

Course L0670: Design of Underwater Vessels	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Peter Hauschildt
Language	DE
Cycle	SoSe
Content	The lectures will give an overview about the design of underwater vessels. The Topics are: 1.) Special requirements on the design of modern, konventional submarines 2.) Design history 3.) Generals description of submarines 4.) Civil submersibles 5.) Diving, trim, stability 6.) Rudders and Propulsion systems 7.) Air Independent propulsion 8.) Signatures 9.) Hydrodynamics and CFD 10.) Weapon- and combatmangementsystems 11.) Safety and rescue 12.) Fatigue and shock 13.) Ships technical systems 14.) Electricals Systems and automation 15.) Logisics 16.) Accomodation Some of the lectures will be Hheld in form of a excursion to ThyssenKrupp Marine Systems in Kiel
Literature	Gabler, Ubootsbau

Course L2066: Lattice-Boltzmann methods for the simulation of free surface flows	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Christian Friedrich Janßen
Language	DE/EN
Cycle	WiSe
Content	This lecture addresses Lattice Boltzmann Methods for the simulation of free surface flows. After an introduction to the basic concepts of kinetic methods (LGCAs, LBM, ...), recent LBM extensions for the simulation of free-surface flows are discussed. Parallel to the lecture, selected maritime free-surface flow problems are to be solved numerically.
Literature	Krüger et al., “The Lattice Boltzmann Method - Principles and Practice”, Springer Zhou, “Lattice Boltzmann Methods for Shallow Water Flows”, Springer Janßen, “Kinetic approaches for the simulation of non-linear free surface flow problems in civil and environmental engineering”, PhD thesis, TU Braunschweig, 2010.

Course L2855: Machine Learning and Dynamics of Maritime Systems I	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Klausur
Examination duration and scale	90 min
Lecturer	Dr. Marco Klein
Language	DE
Cycle	SoSe
Content	
Literature	S. Chakrabarti, Handbook of Offshore Engineering. Elsevier 2005. C.C. Mei, Theory and Applications of Ocean Surface Waves. World Scientific 2004. Weitere Literaturempfehlungen während der Veranstaltung

Course L2856: Machine Learning and Dynamics of Maritime Systems II	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Klausur
Examination duration and scale	90 min
Lecturer	Dr. Marco Klein
Language	DE
Cycle	WiSe
Content	
Literature	S. Chakrabarti, Handbook of Offshore Engineering. Elsevier 2005. C.C. Mei, Theory and Applications of Ocean Surface Waves. World Scientific 2004. Weitere Literaturempfehlungen während der Veranstaltung

Course L2013: Modeling and Simulation of Maritime Systems	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Christian Friedrich Janßen
Language	DE/EN
Cycle	SoSe
Content	In the scope of this lecture, students learn to model and solve selected maritime problems with the help of numerical programs and scripts. First, basic concepts of computational modeling are explained, from the physical modeling and discretization to the implementation and actual numerical solution of the problem. Then, available tools for the implementation and solution process are discussed, including high-level compiled and interpreted programming languages and computer algebra systems (e.g., Python; Matlab, Maple). In the second half of the class, selected maritime problems will be discussed and subsequently solved numerically by the students.
Literature	“Introduction to Computational Modeling Using C and Open-Source Tools” (J.M. Garrido, Chapman and Hall); “Introduction to Computational Models with Python” (J.M. Garrido, Chapman and Hall); “Programming Fundamentals” (MATLAB Handbook, MathWorks);

Course L0072: Offshore Wind Parks	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	45 min
Lecturer	Dr. Alexander Mitzlaff
Language	DE
Cycle	WiSe
Content	• Nonlinear Waves: Stability, pattern formation, solitary states • Bottom Boundary layers: wave boundary layers, scour, stability of marine slopes • Ice-structure interaction • Wave and tidal current energy conversion
Literature	• Chakrabarti, S., Handbook of Offshore Engineering, vol. I&II, Elsevier 2005. • Mc Cormick, M.E., Ocean Wave Energy Conversion, Dover 2007. • Infeld, E., Rowlands, G., Nonlinear Waves, Solitons and Chaos, Cambridge 2000. • Johnson, R.S., A Modern Introduction to the Mathematical Theory of Water Waves, Cambridge 1997. • Lykousis, V. et al., Submarine Mass Movements and Their Consequences, Springer 2007. • Nielsen, P., Coastal Bottom Boundary Layers and Sediment Transport, World Scientific 2005. • Research Articles.

Course L1605: Ship Acoustics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Dietrich Wittekind
Language	DE
Cycle	SoSe
Content	
Literature	

Course L0352: Ship Dynamics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	60 min
Lecturer	Prof. Moustafa Abdel-Maksoud
Language	DE
Cycle	SoSe
Content	Maneuverability of ships • Equations of motion • Hydrodynamic forces and moments • Linear equations and their solutions • Full-scale trials for evaluating the maneuvering performance • Regulations for maneuverability • Rudder Seakeeping • Representation of harmonic processes • Motions of a rigid ship in regular waves • Flow forces on ship cross sections • Strip method • Consequences induced by ship motion in regular waves • Behavior of ships in a stationary sea state • Long-term distribution of seaway influences
Literature	• Abdel-Maksoud, M., Schiffsdynamik, Vorlesungsskript, Institut für Fluiddynamik und Schiffstheorie, Technische Universität Hamburg-Harburg, 2014 • Abdel-Maksoud, M., Ship Dynamics, Lecture notes, Institute for Fluid Dynamic and Ship Theory, Hamburg University of Technology, 2014 • Bertram, V., Practical Ship Design Hydrodynamics, Butterworth-Heinemann, Linacre House - Jordan Hill, Oxford, United Kingdom, 2000 • Bhattacharyya, R., Dynamics of Marine Vehicles, John Wiley & Sons, Canada,1978 • Brix, J. (ed.), Manoeuvring Technical Manual, Seehafen-Verlag, Hamburg, 1993 • Claus, G., Lehmann, E., Östergaard, C). Offshore Structures, I+II, Springer-Verlag. Berlin Heidelberg, Deutschland, 1992 • Faltinsen, O. M., Sea Loads on Ships and Offshore Structures, Cambridge University Press, United Kingdom, 1990 • Handbuch der Werften, Deutschland, 1986 • Jensen, J. J., Load and Global Response of Ships, Elsevier Science, Oxford, United Kingdom, 2001 • Lewis, Edward V. (ed.), Principles of Naval Architecture - Motion in Waves and Controllability, Society of Naval Architects and Marine Engineers, Jersey City, NJ, 1989 • Lewandowski, E. M., The Dynamics of Marine Craft: Maneuvering and Seakeeping, World Scientific, USA, 2004 • Lloyd, A., Ship Behaviour in Rough Weather, Gosport, Chichester, Sussex, United Kingdom, 1998

Course L0240: Selected Topics of Experimental and Theoretical Fluiddynamics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Thomas Rung
Language	DE
Cycle	WiSe
Content	Will be announced at the beginning of the lecture. Exemplary topics are 1. methods and procedures from experimental fluid mechanics 2. rational Approaches towards flow physics modelling 3. selected topics of theoretical computation fluid dynamics 4. turbulent flows
Literature	Wird in der Veranstaltung bekannt gegeben. To be announced during the lecture.

Course L0873: Technical Elements and Fluid Mechanics of Sailing Ships	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Thomas Rung, Peter Schenzle
Language	DE/EN
Cycle	WiSe
Content	Principles of Sailing Mechanics: - Sailing: Propulsion from relative motion - Lifting foils: Sails, wings, rudders, fins, keels - Wind climate: global, seasonal, meteorological, local - Aerodynamics of sails and sailing rigs - Hydrodynamics of Hulls and fins Technical Elements of Sailing: - Traditional and modern sail types - Modern and unconventional wind propulsors - Hull forms and keel-rudder-configurations - Sailing performance Prediction (VPP) - Auxiliary wind propulsion (motor-sailing) Configuration of Sailing Ships: - Balancing hull and sailing rig - Sailing-boats and -yachts - Traditional Tall Sailing Ships - Modern Wind-Ships
Literature	- Vorlesungs-Manuskript mit Literatur-Liste: Verteilt zur Vorlesung - B. Wagner: Fahrtgeschwindigkeitsberechnung für Segelschiffe, IfS-Rep. 132, 1967 - B. Wagner: Sailing Ship Research at the Hamburg University, IfS-Script 2249, 1976 - A.R. Claughton et al.: Sailing Yacht Design 1&2, University of Southampton, 1998 - L. Larsson, R.E. Eliasson: Principles of Yacht Design, Adlard Coles Nautical, London, 2000 - K. Hochkirch: Entwicklung einer Messyacht, Diss. TU Berlin, 2000

Course L0765: Technology of Naval Surface Vessels	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Martin Schöttelndreyer
Language	DE
Cycle	WiSe
Content	• Operational scenarios, tasks, capabilities, requirements • Product and process models, rules and regulations • Survivability: threats, signatures, counter measures • Design characteristics • Energy and propulsion systems • Command and combat systems • Vulnerability: residual strength, residual functionality
Literature	Th. Christensen, H.-D. Ehrenberg, H. Götte, J. Wessel: Entwurf von Fregatten und Korvetten, in: H. Keil (Hrsg.), Handbuch der Werften, Bd. XXV, Schiffahrts-Verlag "Hansa" C. Schroedter & Co., Hamburg (2000) 16th International Ship and Offshore Structures Congress: Committee V.5 - Naval Ship Design (2006) P. G. Gates: Surface Warships - An Introduction to Design Principles, Brassey's Defence Publishers, London (1987)

Module M1168: Special topics of ship structural design

Courses

Title	Typ	Hrs/wk	CP
Special topics of ship structural design (L1571)	Lecture	2	3
Special topics of ship structural design (L1573)	Project-/problem-based Learning	2	3

Module Responsible	Prof. Sören Ehlers
Admission Requirements	None
Recommended Previous Knowledge	Schiffskonstruktion I - II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Design of special ship and offshore structures can be explained by means of their properties including the usage of lightweight materials and structures. Further, possible extreme loads can be explained.
Skills	Methods to design special ship and offshore structures can be used and the usage of lightweight and sandwich structures can be evaluated. Further, methods to assess the structural response under extreme loads can be used.
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.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	30 min
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory

Course L1571: Special topics of ship structural design

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Rüdiger Ulrich Franz von Bock und Polach
Language	DE/EN
Cycle	SoSe
Content	The characteristics of specialised ship types and offshore structures will be explained as well as their structural design considering service and extreme loads. Possible ship types are: RoRo's, Passanger ships, multi-purpose bulker, gas tanker, FPSO's and fast vessels. Further, the use of alternative materials to steel, such as aluminium, fibre reinforced plastics and sandwich constructions, will be explained. The extreme loads will cover: ship collisions, grounding, ice, low temperature, explosions and fire.
Literature	Script und ausgewählte Literature. Script and assorted literature.

Course L1573: Special topics of ship structural design

Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Rüdiger Ulrich Franz von Bock und Polach
Language	DE/EN
Cycle	SoSe
Content	A sub-structure of a specialised ship or offshore structure will be designed also considering extreme loads.
Literature	Script und ausgewählte Literature. Script and assorted literature.

Module M1175: Special Topics of Ship Propulsionand Hydrodynamics of High Speed Water Vehicles

Courses

Title	Typ	Hrs/wk	CP
Hydrodynamics of High Speed Water Vehicles (L1593)	Lecture	3	3
Special Topics of Ship Propulsion (L1589)	Lecture	3	3

Module Responsible	Prof. Moustafa Abdel-Maksoud
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge on ship resistance, ship propulsion and propeller theory
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Understand present research questions in the field of ship propulsion • Explain the present state of the art for the topics considered • Apply given methodology to approach given problems • Evaluate the limits of the present ship propulsion systems • Identify possibilities to extend present methods and technologies • Evaluate the feasibility of further developments
Skills	Students are able to • select and apply suitable computing and simulation methods to determine the hydrodynamic characteristics of ship propulsion systems • model the behavior of ship propulsion systems under different operation conditions by using simplified methods • evaluate critically the investigation results of experimental or numerical investigations
Personal Competence	
Social Competence	Students are able to • solve problems in heterogeneous groups and to document the corresponding results • share new knowledge with group members
Autonomy	Students are able to assess their knowledge by means of exercises and case studies
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	180 min
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L1593: Hydrodynamics of High Speed Water Vehicles

Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Moustafa Abdel-Maksoud
Language	DE/EN
Cycle	SoSe
Content	1. Resistance components of different high speed water vehicles 2. Propulsion units of high speed vehicles 3. Waves resistance in shallow and deep water 4. Surface effect ships (SES) 5. Hydrofoil supported vehicles 6. Semi-displacement vehicles 7. Planning vehicles 8. Slamming 9. Manoeuvrability
Literature	Faltinsen,O. M., Hydrodynamics of High-Speed Marine Vehicles, Cambridge University Press, UK, 2006

Course L1589: Special Topics of Ship Propulsion	
Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Moustafa Abdel-Maksoud
Language	DE/EN
Cycle	SoSe
Content	1. Propeller Geometry 2. Cavitation 3. Model Tests, Propeller-Hull Interaction 4. Pressure Fluctuation / Vibration 5. Potential Theory 6. Propeller Design 7. Controllable Pitch Propellers 8. Ducted Propellers 9. Podded Drives 10. Water Jet Propulsion 11. Voith-Schneider-Propulsors
Literature	• Breslin, J., P., Andersen, P., Hydrodynamics of Ship Propellers, Cambridge Ocean Technology, Series 3, Cambridge University Press, 1996. • Lewis, V. E., ed., Principles of Naval Architecture, Volume II Resistance, Propulsion and Vibration, SNAME, 1988. • N. N., International Confrrence Waterjet 4, RINA London, 2004 • N. N., 1st International Conference on Technological Advances in Podded Propulsion, Newcastle, 2004

Module M0603: Nonlinear Structural Analysis

Courses

Title	Typ	Hrs/wk	CP
Nonlinear Structural Analysis (L0277)	Lecture	3	4
Nonlinear Structural Analysis (L0279)	Recitation Section (small)	1	2

Module Responsible	Prof. Alexander Düster
Admission Requirements	None
Recommended Previous Knowledge	Knowledge of partial differential equations is recommended.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to + give an overview of the different nonlinear phenomena in structural mechanics. + explain the mechanical background of nonlinear phenomena in structural mechanics. + to specify problems of nonlinear structural analysis, to identify them in a given situation and to explain their mathematical and mechanical background.
Skills	Students are able to + model nonlinear structural problems. + select for a given nonlinear structural problem a suitable computational procedure. + apply finite element procedures for nonlinear structural analysis. + critically verify and judge results of nonlinear finite elements. + to transfer their knowledge of nonlinear solution procedures to new problems.
Personal Competence	
Social Competence	Students are able to + solve problems in heterogeneous groups. + present and discuss their results in front of others. + give and accept professional constructive criticism.
Autonomy	Students are able to + assess their knowledge by means of exercises and E-Learning. + acquaint themselves with the necessary knowledge to solve research oriented tasks. + to transform the acquired knowledge to similar problems.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory Materials Science: Specialisation Modeling: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Ship and Offshore Technology: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory

Course L0277: Nonlinear Structural Analysis	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Alexander Düster
Language	DE/EN
Cycle	WiSe
Content	1. Introduction 2. Nonlinear phenomena 3. Mathematical preliminaries 4. Basic equations of continuum mechanics 5. Spatial discretization with finite elements 6. Solution of nonlinear systems of equations 7. Solution of elastoplastic problems 8. Stability problems 9. Contact problems
Literature	[1] Alexander Düster, Nonlinear Structrual Analysis, Lecture Notes, Technische Universität Hamburg-Harburg, 2014. [2] Peter Wriggers, Nonlinear Finite Element Methods, Springer 2008. [3] Peter Wriggers, Nichtlineare Finite-Elemente-Methoden, Springer 2001. [4] Javier Bonet and Richard D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, Cambridge University Press, 2008.

Course L0279: Nonlinear Structural Analysis	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Alexander Düster
Language	DE/EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0751: Vibration Theory

Courses

Title	Typ	Hrs/wk	CP
Vibration Theory (L0701)	Integrated Lecture	4	6

Module Responsible	Prof. Norbert Hoffmann
Admission Requirements	None
Recommended Previous Knowledge	• Calculus • Linear Algebra • Engineering Mechanics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students are able to denote terms and concepts of Vibration Theory and develop them further. • Students know methods of modeling and simulation for free, driven, self-excited and parameter driven vibrations. • Students know about concepts of linear and nonlinear vibration problems. • Students know basic tasks of vibration problems of discrete and continuous systems.
Skills	• Students are able to denote methods of Vibration Theory and develop them further. • Students are able to apply and expand methods of modeling and simulation for free, forced, self-excited and parameter driven vibrations. • Students are able to solve linear and nonlinear vibration problems.
Personal Competence	
Social Competence	• Students can analyze vibration problems, work on them, and reach working results also in teams or groups. • Students are able to document the results of vibration studies also in groups.
Autonomy	• Students are able to individually analyze and solve vibration problems. • Students are able to approach individually research tasks in Vibration Theory.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	2 Hours
Assignment for the Following Curricula	Energy Systems: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Core Qualification: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core Qualification: Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory

Course L0701: Vibration Theory	
Typ	Integrated Lecture
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Norbert Hoffmann
Language	DE/EN
Cycle	WiSe
Content	Linear and Nonlinear Single and Multiple Degree of Freedom Vibrations • Free vibration • Self-excited vibration • Parameter driven vibration • Forced vibration • Multi degree of freedom vibration • Continuum vibration • Irregular vibration
Literature	German - K. Magnus, K. Popp, W. Sextro: Schwingungen. Physikalische Grundlagen und mathematische Behandlung von Schwingungen. English - K. Magnus: Vibrations.

Module M0658: Innovative CFD Approaches

Courses

Title	Typ	Hrs/wk	CP
Application of Innovative CFD Methods in Research and Development (L0239)	Lecture	2	3
Application of Innovative CFD Methods in Research and Development (L1685)	Recitation Section (small)	2	3

Module Responsible	Prof. Thomas Rung
Admission Requirements	None
Recommended Previous Knowledge	Students should have sound knowledge of engineering mathematics (series expansions, internal & vector calculus), and be familiar with the foundations of partial/ordinary differential equations. They are expected to be familiar with engineering fluid mechanics. Basic knowledge of numerical analysis or computational fluid dynamics, e.g. acquired in previous CFD courses, is of advantage but not necessary.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students will acquire a deeper knowledge of recent trends in computational fluid dynamics (CFD), i.e. finite volume, smoothed particle hydrodynamics and lattice Boltzmann approaches, and can relate recent innovations with present challenges in computational fluid mechanics. They are familiar with the similarities and differences between different Eulerian and Lagrangian discretisation and approximation concepts for investigating on the basis of continuum and kinetic theories. Students have the required knowledge to develop, explain, code and apply numerical models concepts to approximate multiphase and multifield problems with grid and particle based methods, respectively. Students know the fundamentals of simulation based PDE constraint optimisation.
Skills	The students are able choose and apply appropriate discretisation concepts and flow physics models. They acquire the ability to code computational algorithms dedicated to finite volumes on unstructured grids & particle-based discretisations & structured lattice Boltzmann arrangements, apply these codes for parameter investigations and supplement interfaces to extract simulation data for an engineering analysis. They are able to sophisticatedly judge different solution strategies.
Personal Competence	
Social Competence	The students are able to discuss problems, present the results of their own analysis, and jointly develop, implement and report on solution strategies that address given technical reference problems in a team. They to lead team sessions and present solutions to experts.
Autonomy	The students can independently analyse innovative methods to solving fluid engineering problems. They are able to critically analyse own results as well as external data with regards to the plausibility and reliability. Students are able to structure and perform a simulation-based investigation.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	**Compulsory** / **Bonus** / **Form** / **Description** Yes / 20 % / Written elaboration
Examination	Oral exam
Examination duration and scale	30 min
Assignment for the Following Curricula	Energy Systems: Core Qualification: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Ship and Offshore Technology: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0239: Application of Innovative CFD Methods in Research and Development

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Thomas Rung
Language	DE/EN
Cycle	WiSe
Content	Computational Optimisation, Parallel Computing, Efficient CFD-Procedures for GPU Archtiectures, Alternative Approximations (Lattice-Boltzmann Methods, Particle Methods), Fluid/Structure-Interaction, Modelling of Hybrid Continua
Literature	Vorlesungsmaterialien /lecture notes

Course L1685: Application of Innovative CFD Methods in Research and Development	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Thomas Rung
Language	DE/EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1147: Research Project Naval Architecture and Ocean Engineering

Courses			
Title	**Typ**	**Hrs/wk**	**CP**

Module Responsible	Dozenten des Studiengangs
Admission Requirements	None
Recommended Previous Knowledge	Subjects of the Master program and the specialisations.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can explain the project as well as their autonomously gained knowledge and relate it to current issues of their field of study. • They can explain the basic scientific methods they have worked with.
Skills	The students are able to autonomously solve a limited scientific task under the guidance of an experienced researcher. They can justify and explain their approach for problem solving; they can draw conclusions from their results, and then can find new ways and methods for their work. Students are capable of comparing and assessing alternative approaches with their own with regard to given criteria.
Personal Competence	
Social Competence	The students are able to condense the relevance and the structure of the project work, the work procedure and the sub-problems for the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to their peers and supervisors.
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the given deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedback from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology.
Workload in Hours	Independent Study Time 360, Study Time in Lecture 0
Credit points	12
Course achievement	None
Examination	Study work
Examination duration and scale	according to FSPO
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Compulsory

Module M1157: Marine Auxiliaries

Courses

Title	Typ	Hrs/wk	CP
Electrical Installation on Ships (L1531)	Lecture	2	2
Electrical Installation on Ships (L1532)	Recitation Section (large)	1	1
Auxiliary Systems on Board of Ships (L1249)	Lecture	2	2
Auxiliary Systems on Board of Ships (L1250)	Recitation Section (large)	1	1

Module Responsible	Prof. Christopher Friedrich Wirz
Admission Requirements	None
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to • name the operating behaviour of consumers, • describe special requirements on the design of supply networks and to the electrical equipment in isolated networks, as e.g. onboard ships, offshore units, factories and emergency power supply systems, • explain power generation and distribution in isolated grids, wave generator systems on ships, • name requirements for network protection, selectivity and operational monitoring, • name the requirements regarding marine equipment and apply to product development, as well as • describe operating procedures of equipment components of standard and specialized ships and derive requirements for product development.
Skills	Students are able to • calculate short-circuit currents, switchgear, • design electrical propulsion systems for ships • design additional machinery components, as well as • to apply basic principles of hydraulics and to develop hydraulic systems.
Personal Competence	
Social Competence	The students are able to communicate and cooperate in a professional environment in the shipbuilding and component supply industry.
Autonomy	The widespread scope of gained knowledge enables the students to handle situations in their future profession independently and confidently.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	20 min
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L1531: Electrical Installation on Ships

Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Günter Ackermann
Language	DE
Cycle	WiSe
Content	• performance in service of electrical consumers. • special requirements for power supply systems and for electrical equipment in isolated systems/networks e. g. aboard ships, offshore installations, factory systems and emergency power supply systems. • power generation and distribution in isolated networks, shaft generators for ships • calculation of short circuits and behaviour of switching devices • protective devices, selectivity monitoring • electrical Propulsion plants for ships
Literature	H. Meier-Peter, F. Bernhardt u. a.: Handbuch der Schiffsbetriebstechnik, Seehafen Verlag (engl. Version: "Compendium Marine Engineering") Gleß, Thamm: Schiffselektrotechnik, VEB Verlag Technik Berlin

Course L1532: Electrical Installation on Ships	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Günter Ackermann
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1249: Auxiliary Systems on Board of Ships	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christopher Friedrich Wirz
Language	DE
Cycle	SoSe
Content	• Vorschriften zur Schiffsausrüstung • Ausrüstungsanlagen auf Standard-Schiffen • Ausrüstungsanlagen auf Spezial-Schiffen • Grundlagen und Systemtechnik der Hydraulik • Auslegung und Betrieb von Ausrüstungsanlagen
Literature	• H. Meyer-Peter, F. Bernhardt: Handbuch der Schiffsbetriebstechnik • H. Watter: Hydraulik und Pneumatik

Course L1250: Auxiliary Systems on Board of Ships	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Christopher Friedrich Wirz
Language	DE
Cycle	SoSe
Content	
Literature	Siehe korrespondierende Vorlesung

Module M1166: Advanced Ship Design

Courses

Title	Typ	Hrs/wk	CP
Advanced Ship Design (L1567)	Lecture	2	4
Advanced Ship Design (L1710)	Recitation Section (large)	2	2

Module Responsible	Prof. Stefan Krüger
Admission Requirements	None
Recommended Previous Knowledge	Ship Design, Hydrostatics, Ship Safety, Resistance and Propulsion
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The most imortant design problems, constraints and methods related to the a.m. ship typs are referenced, based on the list of methods developed in Ship Design I. The a.m. ship types serve as reference vessels where the application shall point out specific design aspects. The lecture closes with a brief introduction of design principles of dry bulk carriers, paper carriers and ouble ended ferries.
Skills	Der Student soll die in Schiffsentwurf I erworbenen Kenntnisse und das zugehörige Methodenwissen konkret an bestimmten Trockenfrachtern sowie an Passagierschiffen vertiefen. Am Ende der Vorlseunbg wird erwartet, dass der Student in der Lage ist, elemantare Schiffsentwürfe durchführen zu können.
Personal Competence	
Social Competence	The student learns to make technical decisions and to get acceptance for his decisions.
Autonomy	Autonomous Eleaboration of Design Information.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	180 min
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory

Course L1567: Advanced Ship Design

Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	WiSe
Content	The most imortant design problems, constraints and methods related to the a.m. ship typs are referenced, based on the list of methods developed in Ship Design I. The a.m. ship types serve as reference vessels where the application shall point out specific design aspects. The lecture closes with a brief introduction of design principles of dry bulk carriers, paper carriers and ouble ended ferries.
Literature	Schneekluth, Entwerfen von Schiffen

Course L1710: Advanced Ship Design

Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1178: Manoeuvrability and Shallow Water Ship Hydrodynamics

Courses

Title	Typ	Hrs/wk	CP
Manoeuvrability of Ships (L1597)	Lecture	2	3
Shallow Water Ship Hydrodynamics (L1598)	Lecture	2	3

Module Responsible	Prof. Moustafa Abdel-Maksoud
Admission Requirements	None
Recommended Previous Knowledge	B.Sc. Schiffbau
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students lern the motion equation and how to describe hydrodynamic forces. They'll will be able 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. Furthermore, the students lern the basics of assessment and prognosis of ship manoeuvrabilit. Basics of characteristics of flows around ships in shallow water regarding ship propulsion and manoeuvrability will be aquired.
Skills	
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	180 min
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Ship and Offshore Technology: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L1597: Manoeuvrability of Ships

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Moustafa Abdel-Maksoud
Language	DE/EN
Cycle	WiSe
Content	• coordinates & degrees of freedom • governing equations of motion • hydrodynamic forces & moments • ruder forces • navigation based on linearised eq.of motion(exemplary solutions, yaw stability) • manoeuvering test (constraint & unconstraint motion) • slender body approximation **Learning Outcomes** Introduction into basic concepts for the assessment and prognosis ship manoeuvrabilit. Ability to develop methods for analysis of manoeuvring behaviour of ships.
Literature	• Crane, C. L. H., Eda, A. L., Principles of Naval Architecture, Chapter 9, Controllability, SNAME, New York, 1989 • Brix, J., Manoeuvring Technical Manual, Seehafen Verlag GmbH, Hamburg 1993 • Söding, H., Manövrieren , Vorlesungsmanuskript, Institut für Fluiddynamik und Schiffstheorie, TUHH, Hamburg, 1995

Course L1598: Shallow Water Ship Hydrodynamics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Moustafa Abdel-Maksoud, Dr. Norbert Stuntz
Language	DE/EN
Cycle	WiSe
Content	• Special Aspects of Shallow Water Hydrodynamics, Vertical and Horizontal Constraints, Irregularities in Channel Bed • Fundamental Equations of Shallow Water Hydrodynamics • Approximation of Shallow Water Waves, Boussinesq’s Approximation • Ship Waves in Deep Water and under critical, non-critical and supercritical Velocities • Solitary Wves, Critical Speed Range, Extinction of Waves • Aspects of Ship motions in Canals with limited water depth
Literature	• PNA (1988): Principle of Naval Architecture, Vol. II, ISBN 0-939773-01-5 • Schneekluth (1988): Hydromechanik zum Schiffsentwurf • Jiang, T. (2001): Ship Waves in Shallow Water, Fortschritt-Berichte VDI, Series 12, No 466, ISBN 3-18-346612-0

Module M1232: Arctic Technology

Courses

Title	Typ	Hrs/wk	CP
Ice Engineering (L1607)	Lecture	2	2
Ice Engineering (L1615)	Recitation Section (small)	1	2
Ship structural design for arctic conditions (L1575)	Project-/problem-based Learning	2	2

Module Responsible	Prof. Sören Ehlers
Admission Requirements	None
Recommended Previous Knowledge	none
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The challenges and requirements due to ice can be explained. Ice loads can be explained and ice strengthening can be understood.
Skills	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.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	30 min
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Ship and Offshore Technology: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L1607: Ice Engineering	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Walter Kuehnlein
Language	DE/EN
Cycle	WiSe
Content	1. Ice, Ice Properties, Ice Failure Modes and Challenges and Requirements due to Ice ◦ Introduction, what is/means ice engineering ◦ Description of different kinds of ice, main ice properties and different ice failure modes ◦ Why is ice so different compared to open water ◦ Presentation of design challenges and requirements for structures and systems in ice covered waters 2. Ice Load Determination and Ice Model Testing ◦ Overview of different empirical equations for simple determination of ice loads ◦ Discussion and interpretation of the different equations and results ◦ Introduction to ice model tests ◦ What are the requirements for ice model tests, what parameters have to be scaled ◦ What can be simulated and how to use the results of such ice model tests 3. Computational Modelling of Ice-Structure Interaction Processes ◦ Dynamic fracture and continuum mechanics for modelling ice-structure interaction processes ◦ Alternative numerical crack propagation modelling methods. Examples of cohesive element models for real life structures. ◦ Discussion of contribution of ice properties, hydrodynamics and rubble. 4. Ice Design Philosophies and Perspectives ◦ What has to be considered when designing structures or systems for ice covered waters ◦ What are the main differences compared to open water design ◦ Ice Management ◦ What are the main ice design philosophies and why is an integrated concept so important for ice **Learning Objectives** 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.
Literature	• Proceedings OMAE • Proceedings POAC • Proceedings ATC

Course L1615: Ice Engineering	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Dr. Walter Kuehnlein
Language	DE/EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1575: Ship structural design for arctic conditions	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Sören Ehlers, Dr. Rüdiger Ulrich Franz von Bock und Polach
Language	DE/EN
Cycle	WiSe
Content	The structural design under ice loads will be carried out for an individual case
Literature	FSICR, IACS PC and assorted publications

Module M1240: Fatigue Strength of Ships and Offshore Structures

Courses

Title	Typ	Hrs/wk	CP
Fatigue Strength of Ships and Offshore Structures (L1521)	Lecture	2	3
Fatigue Strength of Ships and Offshore Structures (L1522)	Recitation Section (small)	2	3

Module Responsible	Prof. Sören Ehlers
Admission Requirements	None
Recommended Previous Knowledge	Structural analysis of ships and/or offshore structures and fundamental knowledge in mechanics and mechanics of materials
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to • describe fatigue loads and stresses, as well as • describe structural behaviour under cyclic loads.
Skills	Students are able to calculate life prediction based on the S-N approach as well as life prediction based on the crack propagation.
Personal Competence	
Social Competence	The students are able to communicate and cooperate in a professional environment in the shipbuilding and component supply industry.
Autonomy	The widespread scope of gained knowledge enables the students to handle situations in their future profession independently and confidently.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	30 min
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Ship and Offshore Technology: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L1521: Fatigue Strength of Ships and Offshore Structures

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Wolfgang Fricke
Language	EN
Cycle	WiSe
Content	1.) Introduction 2.) Fatigue loads and stresses 3.) Structural behaviour under cyclic loads - Structural behaviour under constant amplitude loading - Influence factors on fatigue strength - Material behaviour under contant amplitude loading - Special aspects of welded joints - Structural behaviour under variable amplitude loading 4.) Life prediction based on the S-N approach - Damage accumulation hypotheses - nominal stress approach - structural stress approach - notch stress approach - notch strain approach - numerical analyses 5.) Life prediction based on the crack propagation - basic relationships in fracture mechanics - description of crack propagation - numerical analysis - safety against unstable fracture
Literature	Siehe Vorlesungsskript

Course L1522: Fatigue Strength of Ships and Offshore Structures	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Wolfgang Fricke
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1268: Linear and Nonlinear Waves

Courses

Title	Typ	Hrs/wk	CP
Linear and Nonlinear Waves (L1737)	Project-/problem-based Learning	4	6

Module Responsible	Prof. Norbert Hoffmann
Admission Requirements	None
Recommended Previous Knowledge	Calculus, Algebra, Engineering Mechanics, Vibrations.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students are able to reflect existing terms and concepts in Wave Mechanics • Students are able to identify and express the need to develop and research new terms and concepts.
Skills	• Students are able to apply existing research methods and procedures of wave mechanics. • Students are able to develop novel research methods and procedures in wave mechanics.
Personal Competence	
Social Competence	• Students can reach working results also in groups. • Students can present and communicate working results also in groups.
Autonomy	• Students are able to approach given research tasks individually. • Studetns are able to identify and follow up novel research tasks by themselves.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	2 Hours
Assignment for the Following Curricula	Mechatronics: Specialisation System Design: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory

Course L1737: Linear and Nonlinear Waves	
Typ	Project-/problem-based Learning
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Norbert Hoffmann
Language	DE/EN
Cycle	WiSe

Content	Introduction into the Dynamics of Linear and Nonlinear Waves
	• Linear Waves
	  ◦ Dispersion
	  ◦ Phase and Group Velocity
	  ◦ Envelopes
	  ◦ Discrete Systems
	• Nonlinear Waves
	  ◦ Model Equations
	  ◦ Solitons, Breathers, Extreme Waves
	• Water Waves, Ocean Waves
	  ◦ Airy and Stokes
	  ◦ Natural Sea State
	  ◦ Kinetic Modelling
	• Other topics

Literature	F.K. Kneubühl: Oscillations and Waves. Springer. G.B. Witham, Linear and Nonlinear Waves. Wiley. C.C. Mei, Theory and Applications of Ocean Surface Waves. World Scientific. L.H. Holthuijsen, Waves in Oceanic and Coastal Waters. Cambridge. And others.

Thesis

Master thesis

Educational Aim

The aim of the individual master thesis is to develop the student's project development skills and to combine many of the aspects learned during other modules within a specific topic and a coherent body of work. This will be achieved through students carrying out work into a particular topic relating to their theme and preparing a master thesis.

Learning Outcomes

On completion of the thesis the student is expected to be able to

LO1 Plan and execute an individual project in an appropriate field of study.

LO2 Carry out an in depth investigation of a leading edge topic.

LO3 Prepare, analyse and document project findings.

Syllabus

The individual master thesis is a major exercise undertaken throughout the period of study.

The student will investigate a relevant and agreed topic, adhering to a defined schedule, with the findings being documented in a master thesis.

The thesis may be undertaken in any institute with approval, or wholly in industry.

Based on the work of a project, a student will submit an individual master thesis which forms the main basis for assessment.

Assessment of Learning Outcomes

Criteria

LO1 Plan and execute an individual project in an appropriate field of study.

C1 Coverage, justification and analysis of field of study/topic and objectives.

C2 Rationale; Logical arguments (overall and within text); Flow; Completeness; Structure; Consistency;

Correctness of assumptions, deductions; Methodology used etc.

LO2 Carry out an in depth investigation of a leading edge topic.

C1 Critical analysis (problems and solutions); Objectivity.

C2 Evaluation; Demonstration of concepts; Case Study.

C3 Clarity, completeness and quality of findings and presentation.

LO3 Prepare, analyse and document project findings.

C1 Description of topic (depth and breadth), references to other work, logical development in the field.

C2 Clarity of writing; English; Grammar; Proper use of words; Presentation; Figures; Style; Quality.

C3 Description of outcomes, conclusions and recommendations.

C4 Evidence of contribution.

Module M-002: Master Thesis

Courses

Title	Typ	Hrs/wk	CP

Module Responsible	Professoren der TUHH
Admission Requirements	• According to General Regulations §21 (1): At least 60 credit points have to be achieved in study programme. The examinations board decides on exceptions.
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence *Knowledge*	

	• The students can use specialized knowledge (facts, theories, and methods) of their subject competently on specialized issues. • The students can explain in depth the relevant approaches and terminologies in one or more areas of their subject, describing current developments and taking up a critical position on them. • The students can place a research task in their subject area in its context and describe and critically assess the state of research.
Skills	The students are able: • To select, apply and, if necessary, develop further methods that are suitable for solving the specialized problem in question. • To apply knowledge they have acquired and methods they have learnt in the course of their studies to complex and/or incompletely defined problems in a solution-oriented way. • To develop new scientific findings in their subject area and subject them to a critical assessment.
Personal Competence	
Social Competence	Students can • Both in writing and orally outline a scientific issue for an expert audience accurately, understandably and in a structured way. • Deal with issues competently in an expert discussion and answer them in a manner that is appropriate to the addressees while upholding their own assessments and viewpoints convincingly.
Autonomy	Students are able: • To structure a project of their own in work packages and to work them off accordingly. • To work their way in depth into a largely unknown subject and to access the information required for them to do so. • To apply the techniques of scientific work comprehensively in research of their own.
Workload in Hours	Independent Study Time 900, Study Time in Lecture 0
Credit points	30
Course achievement	None
Examination	Thesis
Examination duration and scale	According to General Regulations
Assignment for the Following Curricula	Civil Engineering: Thesis: Compulsory Bioprocess Engineering: Thesis: Compulsory Chemical and Bioprocess Engineering: Thesis: Compulsory Computer Science: Thesis: Compulsory Digital Journalism: Thesis: Compulsory Electrical Engineering: Thesis: Compulsory Energy Systems: Thesis: Compulsory Environmental Engineering: Thesis: Compulsory Aircraft Systems Engineering: Thesis: Compulsory Global Innovation Management: Thesis: Compulsory Computer Science in Engineering: Thesis: Compulsory Information and Communication Systems: Thesis: Compulsory Interdisciplinary Mathematics: Thesis: Compulsory International Production Management: Thesis: Compulsory International Management and Engineering: Thesis: Compulsory Joint European Master in Environmental Studies - Cities and Sustainability: Thesis: Compulsory Logistics, Infrastructure and Mobility: Thesis: Compulsory Materials Science: Thesis: Compulsory Mechanical Engineering and Management: Thesis: Compulsory Mechatronics: Thesis: Compulsory Biomedical Engineering: Thesis: Compulsory Microelectronics and Microsystems: Thesis: Compulsory Product Development, Materials and Production: Thesis: Compulsory Renewable Energies: Thesis: Compulsory Naval Architecture and Ocean Engineering: Thesis: Compulsory Ship and Offshore Technology: Thesis: Compulsory Teilstudiengang Lehramt Metalltechnik: Thesis: Compulsory Theoretical Mechanical Engineering: Thesis: Compulsory Process Engineering: Thesis: Compulsory Water and Environmental Engineering: Thesis: Compulsory Certification in Engineering & Advisory in Aviation: Thesis: Compulsory