



## **Module Manual**

Master of Science (M.Sc.)

# **Naval Architecture and Ocean Engineering**

Cohort: Winter Term 2021

Updated: 20th April 2023



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## Program description

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### 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**

<b>Module M0523: Business &amp; Management</b>	
<b>Module Responsible</b>	Prof. Matthias Meyer
<b>Admission Requirements</b>	None
<b>Recommended Previous Knowledge</b>	None
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b> <i>Knowledge</i> <ul style="list-style-type: none"> <li>• Students are able to find their way around selected special areas of management within the scope of business management.</li> <li>• Students are able to explain basic theories, categories, and models in selected special areas of business management.</li> <li>• Students are able to interrelate technical and management knowledge.</li> </ul> <i>Skills</i> <ul style="list-style-type: none"> <li>• Students are able to apply basic methods in selected areas of business management.</li> <li>• Students are able to explain and give reasons for decision proposals on practical issues in areas of business management.</li> </ul> <b>Personal Competence</b> <i>Social Competence</i> <ul style="list-style-type: none"> <li>• Students are able to communicate in small interdisciplinary groups and to jointly develop solutions for complex problems</li> </ul> <i>Autonomy</i> <ul style="list-style-type: none"> <li>• Students are capable of acquiring necessary knowledge independently by means of research and preparation of material.</li> </ul>	
<b>Workload in Hours</b>	Depends on choice of courses
<b>Credit points</b>	6

**Courses**

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

Module M0524: Non-technical Courses for Master	
<b>Module Responsible</b>	Dagmar Richter
<b>Admission Requirements</b>	None
<b>Recommended Previous Knowledge</b>	None
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b> <i>Knowledge</i>	<p><b>The Nontechnical Academic Programms (NTA)</b></p> <p>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 <b>teaching architecture</b>, in its <b>teaching and learning arrangements</b>, in <b>teaching areas</b> and by means of teaching offerings in which students can qualify by opting for <b>specific competences</b> and a <b>competence level</b> at the Bachelor's or Master's level. The teaching offerings are pooled in two different catalogues for nontechnical complementary courses.</p> <p><b>The Learning Architecture</b></p> <p>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.</p> <p>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".</p> <p>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.</p> <p><b>Teaching and Learning Arrangements</b></p> <p>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.</p> <p><b>Fields of Teaching</b></p> <p>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.</p> <p>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.</p> <p><b>The Competence Level</b></p> <p>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.</p> <p>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.</p> <p><b>Specialized Competence (Knowledge)</b></p> <p>Students can</p> <ul style="list-style-type: none"> <li>• explain specialized areas in context of the relevant non-technical disciplines,</li> <li>• outline basic theories, categories, terminology, models, concepts or artistic techniques in the disciplines represented in the learning area,</li> <li>• different specialist disciplines relate to their own discipline and differentiate it as well as make connections,</li> <li>• 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,</li> <li>• Can communicate in a foreign language in a manner appropriate to the subject.</li> </ul>
<b>Professional Competence</b> <i>Skills</i>	<p><b>Professional Competence (Skills)</b></p> <p>In selected sub-areas students can</p> <ul style="list-style-type: none"> <li>• apply basic and specific methods of the said scientific disciplines,</li> <li>• question a specific technical phenomena, models, theories from the viewpoint of another, aforementioned specialist discipline,</li> <li>• to handle simple and advanced questions in aforementioned scientific disciplines in a successful manner,</li> <li>• justify their decisions on forms of organization and application in practical questions in contexts that go beyond the technical relationship to the subject.</li> </ul>

<p><b>Personal Competence</b> <i>Social Competence</i></p>	<p><b>Personal Competences (Social Skills)</b></p> <p>Students will be able</p> <ul style="list-style-type: none"> <li>• to learn to collaborate in different manner,</li> <li>• to present and analyze problems in the abovementioned fields in a partner or group situation in a manner appropriate to the addressees,</li> <li>• 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),</li> <li>• to explain nontechnical items to auditorium with technical background knowledge.</li> </ul>
<p><i>Autonomy</i></p>	<p><b>Personal Competences (Self-reliance)</b></p> <p>Students are able in selected areas</p> <ul style="list-style-type: none"> <li>• to reflect on their own profession and professionalism in the context of real-life fields of application</li> <li>• to organize themselves and their own learning processes</li> <li>• to reflect and decide questions in front of a broad education background</li> <li>• to communicate a nontechnical item in a competent way in written form or verbally</li> <li>• to organize themselves as an entrepreneurial subject country (as far as this study-focus would be chosen)</li> </ul>
<b>Workload in Hours</b>	Depends on choice of courses
<b>Credit points</b>	6

**Courses**

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

Module M1233: Numerical Methods in Ship Design			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b> <b>CP</b>
Numerical Methods in Ship Design (L1271)		Lecture	2                  4
Numerical Methods in Ship Design (L1709)		Project-/problem-based Learning	2                  2
<b>Module Responsible</b>	Prof. Stefan Krüger		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b> <i>Knowledge</i> <i>Skills</i>			
<b>Personal Competence</b> <i>Social Competence</i> <i>Autonomy</i>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Oral exam		
<b>Examination duration and scale</b>	45 min		
<b>Assignment for the Following Curricula</b>	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory		

Course L1271: Numerical Methods in Ship Design	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 92, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Stefan Krüger
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	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: <ul style="list-style-type: none"> <li>- Hullform representation, fairing and interpolation</li> <li>- Hullform design by modifying parent hulls</li> <li>- Modelling of subdivison</li> <li>- Volumetric and stability calculations</li> <li>- Mass distributions and longitudinal strength</li> <li>- Hullform Design by CFD- techniques</li> <li>- Propulsor and Rudder Design by CFD Techniques</li> </ul>
<b>Literature</b>	Skript zur Vorlesung.

Course L1709: Numerical Methods in Ship Design	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Stefan Krüger
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course



Module M0601: Structural Analysis of Ships and Offshore Structures				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Structural Analysis of Ships and Offshore Structures (L0272)		Lecture	2	3
Structural Analysis of Ships and Offshore Structures (L0273)		Recitation Section (small)	2	3
<b>Module Responsible</b>	Prof. Alexander Düster			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Mathematics I, II, III, Mechanics I, II, III, IV Differential Equations 2 (Partial Differential Equations)			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	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.			
<i>Skills</i>	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.			
<b>Personal Competence</b>				
<i>Social Competence</i>	Students are able to + solve problems in heterogeneous groups and to document the corresponding results. + share new knowledge with group members.			
<i>Autonomy</i>	Students are able to + assess their knowledge by means of exercises and E-Learning.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	None			
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	2h			
<b>Assignment for the Following Curricula</b>	Naval Architecture and Ocean Engineering: Core Qualification: Compulsory Ship and Offshore Technology: Core Qualification: Compulsory			
Course L0272: Structural Analysis of Ships and Offshore Structures				
<b>Typ</b>	Lecture			
<b>Hrs/wk</b>	2			
<b>CP</b>	3			
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28			
<b>Lecturer</b>	Prof. Alexander Düster			
<b>Language</b>	DE/EN			
<b>Cycle</b>	WiSe			
<b>Content</b>	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			
<b>Literature</b>	[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.			

<b>Course L0273: Structural Analysis of Ships and Offshore Structures</b>	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Alexander Düster
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Basic equations of elastostatics</li> <li>3. Approximation procedures</li> <li>4. The finite element method</li> <li>5. Mechanical models and finite elements for thin-walled structures</li> <li>6. Application to ships and offshore structures</li> </ol>
<b>Literature</b>	<p>[1] Alexander Düster, Structural Analysis of Ships and Offshore Structures, Lecture Notes, Technische Universität Hamburg-Harburg, 125 pages, 2014.</p> <p>[2] G. Clauss, E. Lehmann, C. Östergaard, M.J. Shields, Offshore Structures: Volume II, Strength and Safety for Structural Design, Springer, 1993.</p> <p>[3] G. Clauss, E. Lehmann, C. Östergaard, Meerestechnische Konstruktionen, Springer, 1988.</p>

Module M1146: Ship Vibration			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b> <b>CP</b>
Ship Vibration (L1528)		Lecture	2                  3
Ship Vibration (L1529)		Recitation Section (small)	2                  3
<b>Module Responsible</b>	Dr. Rüdiger Ulrich Franz von Bock und Polach		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Mechanis I - III Structural Analysis of Ships I Fundamentals of Ship Structural Design		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	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 structural components and the entire hull girder; they understand the effect of exciting forces of the propeller and main engine and methods for their determination		
<i>Skills</i>	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		
<b>Personal Competence</b>			
<i>Social Competence</i>	The students are able to communicate and cooperate in a professional environment in the shipbuilding and component supply industry.		
<i>Autonomy</i>	Students are able to detect vibration-prone components on ships, to model the structure, to select suitable calculation methods and to assess the results		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	3 hours		
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Rüdiger Ulrich Franz von Bock und Polach
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction; assessment of vibrations</li> <li>2. Basic equations</li> <li>3. Beams with discrete / distributed masses</li> <li>4. Complex beam systems</li> <li>5. Vibration of plates and Grillages</li> <li>6. Deformation method / practical hints / measurements</li> <li>7. Hydrodynamic masses</li> <li>8. Spectral method</li> <li>9. Hydrodynamic masses acc. to Lewis</li> <li>10. Damping</li> <li>11. Shaft systems</li> <li>12. Propeller excitation</li> <li>13. Engines</li> </ol>
<b>Literature</b>	Siehe Vorlesungsskript

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<b>Course L1529: Ship Vibration</b>	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Rüdiger Ulrich Franz von Bock und Polach
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction; assessment of vibrations</li> <li>2. Basic equations</li> <li>3. Beams with discrete / distributed masses</li> <li>4. Complex beam systems</li> <li>5. Vibration of plates and Grillages</li> <li>6. Deformation method / practical hints / measurements</li> <li>7. Hydrodynamic masses</li> <li>8. Spectral method</li> <li>9. Hydrodynamic masses acc. to Lewis</li> <li>10. Damping</li> <li>11. Shaft systems</li> <li>12. Propeller excitation</li> <li>13. Engines</li> </ol>
<b>Literature</b>	Siehe Vorlesungsskript

Module M1165: Ship Safety				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Ship Safety (L1267)		Lecture	2	4
Ship Safety (L1268)		Recitation Section (large)	2	2
<b>Module Responsible</b>	Prof. Stefan Krüger			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Ship Design, Hydrostatics, Statistical Processes			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The student shall learn to integrate safety aspects into the ship design process. This includes the understanding and application of existing rules as well as the understanding of the safety concept and level which is targeted by a rule. Further, methods of demonstrating equivalent safety levels are introduced.			
<i>Skills</i>	The lectures start with an overview about general safety concepts for technical systems. The maritime safety organizations are introduced, their responses and duties. Then, the general difference between prescriptive and performance based rules is tackled. For different examples in ship design, the influence of the rules on the design is illustrated. Further, limitations of safety 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.			
	<ul style="list-style-type: none"> <li>- Freeboard, water- and weathertight subdivisions, openings</li> <li>- all aspects of intact stability, including special problems such as grain code</li> <li>- damage stability for passenger vessels including Stockholm agreement</li> <li>- damage stability for cargo vessels</li> <li>- on board stability, inclining experiment and stability booklet</li> <li>- Relevant manoeuvring information</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	The student learns to take responsibility for the safety of his design.			
<i>Autonomy</i>	Responsible certification of technical designs.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	None			
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	180 min			
<b>Assignment for the Following Curricula</b>	Naval Architecture and Ocean Engineering: Core Qualification: Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory			

Course L1267: Ship Safety	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 92, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Stefan Krüger
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>The lectures start with an overview about general safety concepts for technical systems. The maritime safety organizations are introduced, their responses and duties. Then, the general difference between prescriptive and performance based rules is tackled. For different examples in ship design, the influence of the rules on the design is illustrated. Further, limitations of safety 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.</p> <ul style="list-style-type: none"> <li>- Freeboard, water- and weathertight subdivisions, openings</li> <li>- all aspects of intact stability, including special problems such as grain code</li> <li>- damage stability for passenger vessels including Stockholm agreement</li> <li>- damage stability for cargo vessels</li> <li>- on board stability, inclining experiment and stability booklet</li> <li>- Relevant manoeuvring information</li> </ul>
<b>Literature</b>	SOLAS, LOAD LINES, CODE ON INTACT STABILITY. Alle IMO, London.

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<b>Course L1268: Ship Safety</b>	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Stefan Krüger
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	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	
<b>Module Responsible</b>	Prof. Moustafa Abdel-Maksoud			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Basic knowledge of ship dynamics as well as stochastic and statistics			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i></p> <ul style="list-style-type: none"> <li>Understand present research questions in the field of ship motion in waves</li> <li>Explain the present state of the art for the topics considered</li> <li>Apply given methodology to approach given problems of seakeeping behavior</li> <li>Evaluate the limits of the present methods</li> <li>Identify possibilities to extend present methods</li> <li>Evaluate the feasibility of further developments</li> </ul> <p><i>Skills</i></p> <p>Students are able to</p> <ul style="list-style-type: none"> <li>select and apply suitable computing and simulation methods to determine the dynamic loads on ships and floating bodies</li> <li>model the behavior of ships and floating bodies under different sea conditions by using simplified methods</li> <li>evaluate critically the investigation results of experimental or numerical studies</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <p>Students are able to</p> <ul style="list-style-type: none"> <li>solve problems in heterogeneous groups and to document the corresponding results</li> <li>share new knowledge with group members</li> </ul> <p><i>Autonomy</i></p> <p>Students are able to</p> <ul style="list-style-type: none"> <li>assess their knowledge by means of exercises</li> <li>think system-oriented</li> <li>decompose complex systems</li> </ul>			
<i>Knowledge</i>				
<i>Skills</i>				
<b>Personal Competence</b>				
<i>Social Competence</i>	Students are able to			
<i>Autonomy</i>	Students are able to			
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	20 %	Exercises	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	180 min			
<b>Assignment for the Following Curricula</b>	Naval Architecture and Ocean Engineering: Core Qualification: Compulsory Ship and Offshore Technology: Core Qualification: Elective Compulsory			

Course L0241: Laboratory on Naval Architecture	
<b>Typ</b>	Practical Course
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Thomas Rung, Dr. Rüdiger Ulrich Franz von Bock und Polach
<b>Language</b>	DE/EN
<b>Cycle</b>	SoSe
<b>Content</b>	<p>The lab is structured into 5 team-based experiments</p> <ol style="list-style-type: none"> <li>1. Resistance test Towing test to investigate a model hull resistance</li> <li>2. Propulsion test Propulsion test for a self propelled hull. Determination of thrust deduction, wake fraction and propulsion efficiency.</li> <li>3. Seakeeping test Investigation of the seakeeping behaviour</li> <li>4. Open water and cavitation test Compilation of an open water diagram and cavitation experiments</li> <li>5. Application of strain measurement techniques</li> </ol> <p>Theoretical instructions will also involve foundations of similarity analysis</p>
<b>Literature</b>	<p>Vorlesungsmanuskript</p> <p>Lecture Notes</p>

Course L1594: Seakeeping of Ships	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Moustafa Abdel-Maksoud
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Numerical methods for the determination of section forces</li> <li>2. Steep waves (Stokes-Theory)</li> <li>3. 3d-potential flow methods</li> <li>4. Time domain simulation of ship motions</li> <li>5. Capsizing</li> <li>6. Slamming</li> </ol>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Söding, H., Schiffe im Seegang I, Vorlesungsmanuskript, Institut für Fluidodynamik und Schiffstheorie, TUHH, Hamburg, 1992</li> <li>• Jensen, G., Söding, H. S., Schiffe im Seegang II, Vorlesungsmanuskript, Institut für Fluidodynamik und Schiffstheorie, TUHH, Hamburg, 2005</li> <li>• Bertram, V., Practical Ship Design Hydrodynamics, Butterworth-Heinemann, Linacre House, Jordan Hill, Oxford, United Kingdom, 2000</li> <li>• Lloyd, A., Ship Behaviour in Rough Weather, Gosport, Chichester, Sussex, United Kingdom, 1998</li> <li>• Jensen, J. J., Load and Global Response of Ships, Elsevier Science, Oxford, United Kingdom, 2001</li> </ul>

Course L1619: Seakeeping of Ships	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	2
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Moustafa Abdel-Maksoud
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	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
<b>Module Responsible</b>	Prof. Moustafa Abdel-Maksoud		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Solid knowledge and competences in mechanics, fluid dynamics and analysis (series, periodic functions, continuity, differentiability, integration, multiple variables, ordinary and partial differential equations, boundary value problems, initial conditions and eigenvalue problems).		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> 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.</p> <p>In detail, the students should be able to</p> <ul style="list-style-type: none"> <li>• describe the different aspects and topics in Maritime Technology,</li> <li>• apply existing methods to problems in Maritime Technology,</li> <li>• discuss limitations in present day approaches and perspectives in the future,</li> <li>• Techniques for the analysis of offshore systems,</li> <li>• Modeling and evaluation of dynamic systems,</li> <li>• System-oriented thinking, decomposition of complex systems.</li> </ul> <p><i>Skills</i> 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.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> 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 technique of subsequent working days. The collaboration has to be illustrated in a community presentation of the results.</p> <p><i>Autonomy</i> 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.</p>		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	180 min		
<b>Assignment for the Following Curricula</b>	Naval Architecture and Ocean Engineering: Core Qualification: Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory		

Course L0068: Analysis of Maritime Systems	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Moustafa Abdel-Maksoud, Dr. Alexander Mitzlaff
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Hydrostatic analysis                             <ul style="list-style-type: none"> <li>◦ Buoyancy,</li> <li>◦ Stability,</li> </ul> </li> <li>2. Hydrodynamic analysis                             <ul style="list-style-type: none"> <li>◦ Froude-Krylov force</li> <li>◦ Morison's equation,</li> <li>◦ Radiation and diffraction</li> <li>◦ transparent/compact structures</li> </ul> </li> <li>3. Evaluation of offshore structures: Reliability techniques (security, reliability, disposability)                             <ul style="list-style-type: none"> <li>◦ Short-term statistics</li> <li>◦ Long-term statistics and extreme events</li> </ul> </li> </ol>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• G. Clauss, E. Lehmann, C. Østergaard. Offshore Structures Volume I: Conceptual Design and Hydrodynamics. Springer Verlag Berlin, 1992</li> <li>• E. V. Lewis (Editor), Principles of Naval Architecture ,SNAME, 1988</li> <li>• Journal of Offshore Mechanics and Arctic Engineering</li> <li>• Proceedings of International Conference on Offshore Mechanics and Arctic Engineering</li> <li>• S. Chakrabarti (Ed.), Handbook of Offshore Engineering, Volumes 1-2, Elsevier, 2005</li> <li>• S. K. Chakrabarti, Hydrodynamics of Offshore Structures , WIT Press, 2001</li> </ul>

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

<b>Course L0070: Introduction to Maritime Technology</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Walter Kuehnlein, Dr. Sven Hoog
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>1. Introduction</p> <ul style="list-style-type: none"> <li>• Ocean Engineering and Marine Research</li> <li>• The potentials of the seas</li> <li>• Industries and occupational structures</li> </ul> <p>2. Coastal and offshore Environmental Conditions</p> <ul style="list-style-type: none"> <li>• Physical and chemical properties of sea water and sea ice</li> <li>• Flows, waves, wind, ice</li> <li>• Biosphere</li> </ul> <p>3. Response behavior of Technical Structures</p> <p>4. Maritime Systems and Technologies</p> <ul style="list-style-type: none"> <li>• General Design and Installation of Offshore-Structures</li> <li>• Geophysical and Geotechnical Aspects</li> <li>• Fixed and Floating Platforms</li> <li>• Mooring Systems, Risers, Pipelines</li> <li>• Energy conversion: Wind, Waves, Tides</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Chakrabarti, S., Handbook of Offshore Engineering, vol. I/II, Elsevier 2005.</li> <li>• Gerwick, B.C., Construction of Marine and Offshore Structures, CRC-Press 1999.</li> <li>• Wagner, P., Meerestechnik, Ernst&amp;Sohn 1990.</li> <li>• Clauss, G., Meerestechnische Konstruktionen, Springer 1988.</li> <li>• Knauss, J.A., Introduction to Physical Oceanography, Waveland 2005.</li> <li>• Wright, J. et al., Waves, Tides and Shallow-Water Processes, Butterworth 2006.</li> <li>• Faltinsen, O.M., Sea Loads on Ships and Offshore Structures, Cambridge 1999.</li> </ul>

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

Module M0604: High-Order FEM				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
High-Order FEM (L0280)		Lecture	3	4
High-Order FEM (L0281)		Recitation Section (large)	1	2
<b>Module Responsible</b>	Prof. Alexander Düster			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Knowledge of partial differential equations is recommended.			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	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.			
<i>Skills</i>	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.			
<b>Personal Competence</b>				
<i>Social Competence</i>	Students are able to + solve problems in heterogeneous groups and to document the corresponding results.			
<i>Autonomy</i>	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.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	10 %	Presentation	Forschendes Lernen
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 min			
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Alexander Düster
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Motivation</li> <li>3. Hierarchic shape functions</li> <li>4. Mapping functions</li> <li>5. Computation of element matrices, assembly, constraint enforcement and solution</li> <li>6. Convergence characteristics</li> <li>7. Mechanical models and finite elements for thin-walled structures</li> <li>8. Computation of thin-walled structures</li> <li>9. Error estimation and hp-adaptivity</li> <li>10. High-order fictitious domain methods</li> </ol>
<b>Literature</b>	<p>[1] Alexander Düster, High-Order FEM, Lecture Notes, Technische Universität Hamburg-Harburg, 164 pages, 2014</p> <p>[2] Barna Szabo, Ivo Babuska, Introduction to Finite Element Analysis - Formulation, Verification and Validation, John Wiley &amp; Sons, 2011</p>

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

Module M1234: Ship propellers and cavitation				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Cavitation (L1596)		Lecture	2	3
Marine Propellers (L1270)		Project-/problem-based Learning	2	1
Marine Propellers (L1269)		Lecture	2	2
<b>Module Responsible</b>	Prof. Stefan Krüger			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>				
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b> <i>Knowledge</i> <i>Skills</i>				
<b>Personal Competence</b> <i>Social Competence</i> <i>Autonomy</i>				
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84			
<b>Credit points</b>	6			
<b>Course achievement</b>	None			
<b>Examination</b>	Oral exam			
<b>Examination duration and scale</b>	45 min			
<b>Assignment for the Following Curricula</b>	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory			

Course L1596: Cavitation	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Moustafa Abdel-Maksoud
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Phenomenon and type of cavitation</li> <li>• Test facilities and instrumentations</li> <li>• Dynamics of bubbles</li> <li>• Bubbles cavitation</li> <li>• Supercavitation</li> <li>• Ventilated supercavities</li> <li>• Vortex cavitation</li> <li>• Sheet cavitation</li> <li>• Cavitation in rotary machines</li> <li>• Numerical cavitation models I</li> <li>• Numerical cavitation models II</li> <li>• Pressure fluctuation</li> <li>• Erosion and noise</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Lewis, V. E. (Ed.) , Principles of Naval Architecture, Resistance Propulsion, Vibration, Volume II, Controllability, SNAME, New York, 1989.</li> <li>• Isay, W. H., Kavitation, Schiffahrt-Verlag Hansa, Hamburg, 1989.</li> <li>• Franc, J.-P., Michel, J.-M. Fundamentals of Cavitation, Kluwer Academic Publisher, 2004.</li> <li>• Lecoffre, Y., Cavitation Bubble Trackers, Balkema / Rotterdam / Brookfield, 1999.</li> <li>• Brennen, C. E., Cavitation and Bubble Dynamics, Oxford University Press, 1995.</li> </ul>

Course L1270: Marine Propellers	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	2
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Stefan Krüger
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	The lectures starts with the description of the propeller blade outline parameters. The design fundamentals 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 phenomena which are relevant for the determination of pressure fluctuations.
<b>Literature</b>	W.H. Isay, Propellertheorie. Springer Verlag.

Course L1269: Marine Propellers	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Stefan Krüger
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	The lectures starts with the description of the propeller blade outline parameters. The design fundamentals 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 phenomena which are relevant for the determination of pressure fluctuations.
<b>Literature</b>	W.H. Isay, Propellertheorie. Springer Verlag.

Module M0605: Computational Structural Dynamics				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Computational Structural Dynamics (L0282)		Lecture	3	4
Computational Structural Dynamics (L0283)		Recitation Section (small)	1	2
<b>Module Responsible</b>	Prof. Alexander Düster			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Knowledge of partial differential equations is recommended.			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	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.			
<i>Skills</i>	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.			
<b>Personal Competence</b>				
<i>Social Competence</i>	Students are able to + solve problems in heterogeneous groups and to document the corresponding results.			
<i>Autonomy</i>	Students are able to + acquire independently knowledge to solve complex problems.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	None			
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	2h			
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Alexander Düster
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	1. Motivation 2. Basics of dynamics 3. Time integration methods 4. Modal analysis 5. Fourier transform 6. Applications
<b>Literature</b>	[1] K.-J. Bathe, Finite-Elemente-Methoden, Springer, 2002. [2] J.L. Humar, Dynamics of Structures, Taylor & Francis, 2012.



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

Module M0606: Numerical Algorithms in Structural Mechanics				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Numerical Algorithms in Structural Mechanics (L0284)		Lecture	2	3
Numerical Algorithms in Structural Mechanics (L0285)		Recitation Section (small)	2	3
<b>Module Responsible</b>	Prof. Alexander Düster			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Knowledge of partial differential equations is recommended.			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	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.			
<i>Skills</i>	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 language (here C++). + critically judge and verify numerical algorithms.			
<b>Personal Competence</b>				
<i>Social Competence</i>	Students are able to + solve problems in heterogeneous groups and to document the corresponding results.			
<i>Autonomy</i>	Students are able to + acquire independently knowledge to solve complex problems.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	None			
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	2h			
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Alexander Düster
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	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
<b>Literature</b>	[1] D. Yang, C++ and object-oriented numeric computing, Springer, 2001. [2] K.-J. Bathe, Finite-Elemente-Methoden, Springer, 2002.

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

Module M0657: Computational Fluid Dynamics II				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Computational Fluid Dynamics II (L0237)		Lecture	2	3
Computational Fluid Dynamics II (L0421)		Recitation Section (large)	2	3
<b>Module Responsible</b>	Prof. Thomas Rung			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Basics of computational and general thermo/fluid dynamics			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	Establish a thorough understanding of Finite-Volume approaches. Familiarise with details of the theoretical background of complex CFD algorithms.			
<i>Skills</i>	Ability to manage of interface problems and build-up of coding skills. Ability to evaluate, assess and benchmark different solution options.			
<b>Personal Competence</b>				
<i>Social Competence</i>	Practice of team working during team exercises.			
<i>Autonomy</i>	Independent analysis of specific solution approaches.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	None			
<b>Examination</b>	Oral exam			
<b>Examination duration and scale</b>	0.5h-0.75h			
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Thomas Rung
<b>Language</b>	DE/EN
<b>Cycle</b>	SoSe
<b>Content</b>	Computational Modelling of complex single- and multiphase flows using higher-order approximations for unstructured grids and meshless particle-based methods.
<b>Literature</b>	1) Vorlesungsmanuskript und Übungsunterlagen  2) J.H. Ferziger, M. Peric: Computational Methods for Fluid Dynamics, Springer

Course L0421: Computational Fluid Dynamics II	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Thomas Rung
<b>Language</b>	DE/EN
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	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	
<b>Module Responsible</b>	Prof. Christopher Friedrich Wirz			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>				
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	Students can <ul style="list-style-type: none"> <li>• explain different types four / two-stroke engines and assign types to given engines,</li> <li>• name definitions and characteristics, as well as</li> <li>• elaborate on special features of the heavy oil operation, lubrication and cooling.</li> </ul>			
<i>Skills</i>	Students can <ul style="list-style-type: none"> <li>• evaluate the interaction of ship, engine and propeller,</li> <li>• use relationships between gas exchange, flushing, air demand, charge injection and combustion for the design of systems,</li> <li>• design waste heat recovery, starting systems, controls, automation, foundation and design machinery spaces , and</li> <li>• apply evaluation methods for excited motor noise and vibration.</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	The students are able to communicate and cooperate in a professional environment in the shipbuilding and component supply industry.			
<i>Autonomy</i>	The widespread scope of gained knowledge enables the students to handle situations in their future profession independently and confidently.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	None			
<b>Examination</b>	Oral exam			
<b>Examination duration and scale</b>	20 min			
<b>Assignment for the Following Curricula</b>	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			

<b>Course L0637: Marine Diesel Engine Plants</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Christopher Friedrich Wirz
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Historischer Überblick</li> <li>• Bauarten von Vier- und Zweitaktmotoren als Schiffsmotoren</li> <li>• Vergleichsprozesse, Definitionen, Kenndaten</li> <li>• Zusammenwirken von Schiff, Motor und Propeller</li> <li>• Ausgeführte Schiffsdieselmotoren</li> <li>• Gaswechsel, Spülverfahren, Luftbedarf</li> <li>• Aufladung von Schiffsdieselmotoren</li> <li>• Einspritzung und Verbrennung</li> <li>• Schwerölbetrieb</li> <li>• Schmierung</li> <li>• Kühlung</li> <li>• Wärmebilanz</li> <li>• Abwärmenutzung</li> <li>• Anlassen und Umsteuern</li> <li>• Regelung, Automatisierung, Überwachung</li> <li>• Motorerregte Geräusche und Schwingungen</li> <li>• Fundamentierung</li> <li>• Gestaltung von Maschinenräumen</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• D. Woodyard: Pounder's Marine Diesel Engines</li> <li>• H. Meyer-Peter, F. Bernhardt: Handbuch der Schiffsbetriebstechnik</li> <li>• K. Kuiken: Diesel Engines</li> <li>• Mollenhauer, Tschöke: Handbuch Dieselmotoren</li> <li>• Projektierungsunterlagen der Motorenhersteller</li> </ul>

<b>Course L0638: Marine Diesel Engine Plants</b>	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Christopher Friedrich Wirz
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	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	
<b>Module Responsible</b>	Prof. Carlos Jahn			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	none			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	<p>Th</p> <p>After completing the module, students can...</p> <ul style="list-style-type: none"> <li>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;</li> <li>explain and evaluate different types of seaport terminals and their specific characteristics (cargo, transshipment technologies, logistic functional areas);</li> <li>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;</li> <li>identify future developments and trends regarding the planning and control of innovative seaport terminals and discuss them in a problem-oriented manner.</li> </ul>			
<i>Skills</i>	<p>After completing the module, students will be able to...</p> <ul style="list-style-type: none"> <li>recognize functional areas in ports and seaport terminals;</li> <li>define and evaluate suitable operating systems for container terminals;</li> <li>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;</li> <li>reliably estimate which boundary conditions influence common logistics indicators in the static planning of selected terminal types and to what extent.</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	<p>After completing the module, students can...</p> <ul style="list-style-type: none"> <li>transfer the acquired knowledge to further questions of port logistics;</li> <li>discuss and successfully organize extensive task packages in small groups;</li> <li>in small groups, document work results in writing in an understandable form and present them to an appropriate extent.</li> </ul>			
<i>Autonomy</i>	<p>After completing the module, the students are able to...</p> <ul style="list-style-type: none"> <li>research and select specialist literature, including standards, guidelines and journal papers, and to develop the contents independently;</li> <li>submit own parts in an extensive written elaboration in small groups in due time and to present them jointly within a fixed time frame.</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	15 %	Written elaboration	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 minutes			
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Carlos Jahn
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>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.</p> <p>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 characteristic layouts and the technical equipment used as well as the ongoing digitization and interaction of the players involved.</p> <p>In addition, renowned guest speakers from science and practice will be regularly invited to discuss some lecture-relevant topics from alternative perspectives.</p> <p>The following contents will be conveyed in the lectures:</p> <ul style="list-style-type: none"> <li>• Instruction of structures and processes in the port</li> <li>• Planning, control, implementation and monitoring of material and information flows in the port</li> <li>• Fundamentals of different terminals, characteristic layouts and the technical equipment used</li> <li>• Handling of current issues in port logistics</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Alderton, Patrick (2013). Port Management and Operations.</li> <li>• Biebig, Peter and Althof, Wolfgang and Wagener, Norbert (2017). Seeverkehrswirtschaft: Kompendium.</li> <li>• Brinkmann, Birgitt. Seehäfen: Planung und Entwurf. Berlin Heidelberg: Springer-Verlag, 2005.</li> <li>• Büter, Clemens (2013). Außenhandel: Grundlagen internationaler Handelsbeziehungen.</li> <li>• Gleissner, Harald and Femerling, J. Christian (2012). Logistik: Grundlagen, Übungen, Fallbeispiele.</li> <li>• Jahn, Carlos; Saxe, Sebastian (Hg.). Digitalization of Seaports - Visions of the Future, Stuttgart: Fraunhofer Verlag, 2017.</li> <li>• Kummer, Sebastian (2019). Einführung in die Verkehrswirtschaft</li> <li>• Lun, Y.H.V. and Lai, K.-H. and Cheng, T.C.E. (2010). Shipping and Logistics Management.</li> <li>• Woitschütze, Claus-Peter (2013). Verkehrsgeografie.</li> </ul>

Course L1473: Port Logistics	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Carlos Jahn
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>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.</p>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Alderton, Patrick (2013). Port Management and Operations.</li> <li>• Biebig, Peter and Althof, Wolfgang and Wagener, Norbert (2017). Seeverkehrswirtschaft: Kompendium.</li> <li>• Brinkmann, Birgitt. Seehäfen: Planung und Entwurf. (2005) Berlin Heidelberg: Springer-Verlag.</li> <li>• Büter, Clemens (2013). Außenhandel: Grundlagen internationaler Handelsbeziehungen.</li> <li>• Gleissner, Harald and Femerling, J. Christian (2012). Logistik: Grundlagen, Übungen, Fallbeispiele.</li> <li>• Jahn, Carlos; Saxe, Sebastian (Hg.) (2017) Digitalization of Seaports - Visions of the Future, Stuttgart: Fraunhofer Verlag.</li> <li>• Kummer, Sebastian (2019). Einführung in die Verkehrswirtschaft</li> <li>• Lun, Y.H.V. and Lai, K.-H. and Cheng, T.C.E. (2010). Shipping and Logistics Management.</li> <li>• Woitschütze, Claus-Peter (2013). Verkehrsgeografie.</li> </ul>





<b>Course L1896: Outfitting and Operation of Special Purpose Offshore Ships</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Examination Form</b>	Mündliche Prüfung
<b>Examination duration and scale</b>	30 min
<b>Lecturer</b>	Dr. Hendrik Vorhölter
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>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 majority of offshore vessels will be addressed: rules and regulations, determination of operational limits as well as mooring and dynamic positioning.</p> <p>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 engaged 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:</p> <ul style="list-style-type: none"> <li>- Anchor handling and platform supply vessels</li> <li>- Cable -and pile lay vessels</li> <li>- Jack-up vessels</li> <li>- Heavy lift and offshore construction vessels</li> <li>- Dredgers and rock dumping vessels</li> <li>- Diving support vessels</li> </ul>
<b>Literature</b>	<p>Chakrabarti, S. (2005): Handbook of Offshore Engineering. Elsevier. Amsterdam, London</p> <p>Volker Patzold (2008): Der Nassabbau. Springer. Berlin</p> <p>Milwee, W. (1996): Modern Marine Salvage. Md Cornell Maritime Press. Centreville.</p> <p>DNVGL-ST-N001 „Marine Operations and Marin Warranty“</p> <p>IMCA M 103 “The Design and Operation of Dynamically Positioned Vessels” 2007-12</p> <p>IMCA M 182 “The Safe Operation of Dynamically Positioned Offshore Supply Vessels” 2006-03</p> <p>IMCA M 187 “Lifting Operations” 2007-10</p> <p>IMCA SEL 185 “Transfer of Personnel to and from Offshore Vessels” 2010-03</p>

Course L0670: Design of Underwater Vessels	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Examination Form</b>	Mündliche Prüfung
<b>Examination duration and scale</b>	30 min
<b>Lecturer</b>	Peter Hauschildt
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>The lectures will give an overview about the design of underwater vessels. The Topics are:</p> <ol style="list-style-type: none"> <li>1.) Special requirements on the design of modern, konventionel submarines</li> <li>2.) Design history</li> <li>3.) Generals description of submarines</li> <li>4.) Civil submersibles</li> <li>5.) Diving, trim, stability</li> <li>6.) Rudders and Propulsion systems</li> <li>7.) Air Independent propulsion</li> <li>8.) Signatures</li> <li>9.) Hydrodynamics and CFD</li> <li>10.) Weapon- and combatmangementsystems</li> <li>11.) Safety and rescue</li> <li>12.) Fatigue and shock</li> <li>13.) Ships technical systems</li> <li>14.) Electricals Systems and automation</li> <li>15.) Logisics</li> <li>16.) Accomodation</li> </ol> <p>Some of the lectures will be Hheld in form of a excursion to ThyssenKrupp Marine Systems in Kiel</p>
<b>Literature</b>	Gabler, Ubootsbau

Course L2066: Lattice-Boltzmann methods for the simulation of free surface flows	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Examination Form</b>	Mündliche Prüfung
<b>Examination duration and scale</b>	30 min
<b>Lecturer</b>	Dr. Christian Friedrich Janßen
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>This lecture addresses Lattice Boltzmann Methods for the simulation of free surface flows. After an introduction to the basic concepts of kinetic methods (LGCA's, 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.</p>
<b>Literature</b>	<p>Krüger et al., "The Lattice Boltzmann Method - Principles and Practice", Springer</p> <p>Zhou, "Lattice Boltzmann Methods for Shallow Water Flows", Springer</p> <p>Janßen, "Kinetic approaches for the simulation of non-linear free surface flow problems in civil and environmental engineering", PhD thesis, TU Braunschweig, 2010.</p>

Course L2855: Machine Learning and Dynamics of Maritime Systems I	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	90 min
<b>Lecturer</b>	Dr. Marco Klein
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	
<b>Literature</b>	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	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	90 min
<b>Lecturer</b>	Dr. Marco Klein
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	
<b>Literature</b>	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	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Examination Form</b>	Mündliche Prüfung
<b>Examination duration and scale</b>	30 min
<b>Lecturer</b>	Dr. Christian Friedrich Janßen
<b>Language</b>	DE/EN
<b>Cycle</b>	SoSe
<b>Content</b>	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.
<b>Literature</b>	"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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Examination Form</b>	Mündliche Prüfung
<b>Examination duration and scale</b>	45 min
<b>Lecturer</b>	Dr. Alexander Mitzlaff
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Nonlinear Waves: Stability, pattern formation, solitary states</li> <li>• Bottom Boundary layers: wave boundary layers, scour, stability of marine slopes</li> <li>• Ice-structure interaction</li> <li>• Wave and tidal current energy conversion</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Chakrabarti, S., Handbook of Offshore Engineering, vol. I&amp;II, Elsevier 2005.</li> <li>• Mc Cormick, M.E., Ocean Wave Energy Conversion, Dover 2007.</li> <li>• Infeld, E., Rowlands, G., Nonlinear Waves, Solitons and Chaos, Cambridge 2000.</li> <li>• Johnson, R.S., A Modern Introduction to the Mathematical Theory of Water Waves, Cambridge 1997.</li> <li>• Lykousis, V. et al., Submarine Mass Movements and Their Consequences, Springer 2007.</li> <li>• Nielsen, P., Coastal Bottom Boundary Layers and Sediment Transport, World Scientific 2005.</li> <li>• Research Articles.</li> </ul>

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

Course L0352: Ship Dynamics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	60 min
<b>Lecturer</b>	Prof. Moustafa Abdel-Maksoud
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Maneuverability of ships</p> <ul style="list-style-type: none"> <li>• Equations of motion</li> <li>• Hydrodynamic forces and moments</li> <li>• Linear equations and their solutions</li> <li>• Full-scale trials for evaluating the maneuvering performance</li> <li>• Regulations for maneuverability</li> <li>• Rudder</li> </ul> <p>Seakeeping</p> <ul style="list-style-type: none"> <li>• Representation of harmonic processes</li> <li>• Motions of a rigid ship in regular waves</li> <li>• Flow forces on ship cross sections</li> <li>• Strip method</li> <li>• Consequences induced by ship motion in regular waves</li> <li>• Behavior of ships in a stationary sea state</li> <li>• Long-term distribution of seaway influences</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Abdel-Maksoud, M., Schiffsdynamik, Vorlesungsskript, Institut für Fluidodynamik und Schiffstheorie, Technische Universität Hamburg-Harburg, 2014</li> <li>• Abdel-Maksoud, M., Ship Dynamics, Lecture notes, Institute for Fluid Dynamic and Ship Theory, Hamburg University of Technology, 2014</li> <li>• Bertram, V., Practical Ship Design Hydrodynamics, Butterworth-Heinemann, Linacre House - Jordan Hill, Oxford, United Kingdom, 2000</li> <li>• Bhattacharyya, R., Dynamics of Marine Vehicles, John Wiley &amp; Sons, Canada, 1978</li> <li>• Brix, J. (ed.), Manoeuvring Technical Manual, Seehafen-Verlag, Hamburg, 1993</li> <li>• Claus, G., Lehmann, E., Østergaard, C), Offshore Structures, I+II, Springer-Verlag, Berlin Heidelberg, Deutschland, 1992</li> <li>• Faltinsen, O. M., Sea Loads on Ships and Offshore Structures, Cambridge University Press, United Kingdom, 1990</li> <li>• Handbuch der Werften, Deutschland, 1986</li> <li>• Jensen, J. J., Load and Global Response of Ships, Elsevier Science, Oxford, United Kingdom, 2001</li> <li>• Lewis, Edward V. (ed.), Principles of Naval Architecture - Motion in Waves and Controllability, Society of Naval Architects and Marine Engineers, Jersey City, NJ, 1989</li> <li>• Lewandowski, E. M., The Dynamics of Marine Craft: Maneuvering and Seakeeping, World Scientific, USA, 2004</li> <li>• Lloyd, A., Ship Behaviour in Rough Weather, Gosport, Chichester, Sussex, United Kingdom, 1998</li> </ul>

Course L0240: Selected Topics of Experimental and Theoretical Fluid Dynamics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Examination Form</b>	Mündliche Prüfung
<b>Examination duration and scale</b>	30 min
<b>Lecturer</b>	Prof. Thomas Rung
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Will be announced at the beginning of the lecture. Exemplary topics are</p> <ol style="list-style-type: none"> <li>1. methods and procedures from experimental fluid mechanics</li> <li>2. rational Approaches towards flow physics modelling</li> <li>3. selected topics of theoretical computation fluid dynamics</li> <li>4. turbulent flows</li> </ol>
<b>Literature</b>	Wird in der Veranstaltung bekannt gegeben. To be announced during the lecture.

Course L0873: Technical Elements and Fluid Mechanics of Sailing Ships	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Examination Form</b>	Mündliche Prüfung
<b>Examination duration and scale</b>	30 min
<b>Lecturer</b>	Prof. Thomas Rung, Peter Schenzle
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Principles of Sailing Mechanics:</p> <ul style="list-style-type: none"> <li>- Sailing: Propulsion from relative motion</li> <li>- Lifting foils: Sails, wings, rudders, fins, keels</li> <li>- Wind climate: global, seasonal, meteorological, local</li> <li>- Aerodynamics of sails and sailing rigs</li> <li>- Hydrodynamics of Hulls and fins</li> </ul> <p>Technical Elements of Sailing:</p> <ul style="list-style-type: none"> <li>- Traditional and modern sail types</li> <li>- Modern and unconventional wind propulsors</li> <li>- Hull forms and keel-rudder-configurations</li> <li>- Sailing performance Prediction (VPP)</li> <li>- Auxiliary wind propulsion (motor-sailing)</li> </ul> <p>Configuration of Sailing Ships:</p> <ul style="list-style-type: none"> <li>- Balancing hull and sailing rig</li> <li>- Sailing-boats and -yachts</li> <li>- Traditional Tall Sailing Ships</li> <li>- Modern Wind-Ships</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>- Vorlesungs-Manuskript mit Literatur-Liste: Verteilt zur Vorlesung</li> <li>- B. Wagner: Fahrtgeschwindigkeitsberechnung für Segelschiffe, IfS-Rep. 132, 1967</li> <li>- B. Wagner: Sailing Ship Research at the Hamburg University, IfS-Script 2249, 1976</li> <li>- A.R. Cloughton et al.: Sailing Yacht Design 1&amp;2, University of Southampton, 1998</li> <li>- L. Larsson, R.E. Eliasson: Principles of Yacht Design, Adlard Coles Nautical, London, 2000</li> <li>- K. Hochkirch: Entwicklung einer Messyacht, Diss. TU Berlin, 2000</li> </ul>

<b>Course L0765: Technology of Naval Surface Vessels</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Examination Form</b>	Mündliche Prüfung
<b>Examination duration and scale</b>	30 min
<b>Lecturer</b>	Dr. Martin Schöttelndreyer
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Operational scenarios, tasks, capabilities, requirements</li> <li>• Product and process models, rules and regulations</li> <li>• Survivability: threats, signatures, counter measures</li> <li>• Design characteristics</li> <li>• Energy and propulsion systems</li> <li>• Command and combat systems</li> <li>• Vulnerability: residual strength, residual functionality</li> </ul>
<b>Literature</b>	<p>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 &amp; Co., Hamburg (2000)</p> <p>16th International Ship and Offshore Structures Congress: Committee V.5 - Naval Ship Design (2006)</p> <p>P. G. Gates: Surface Warships - An Introduction to Design Principles, Brassey's Defence Publishers, London (1987)</p>



**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	
<b>Module Responsible</b>	Prof. Sören Ehlers			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Schiffskonstruktion I - II			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i> 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.</p> <p><i>Skills</i> 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.</p>			
<b>Personal Competence</b>	<p><i>Social Competence</i> Students are capable to present their structural design and discuss their decisions constructively in a group.</p> <p><i>Autonomy</i> 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.</p>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	None			
<b>Examination</b>	Oral exam			
<b>Examination duration and scale</b>	30 min			
<b>Assignment for the Following Curricula</b>	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory			

**Course L1571: Special topics of ship structural design**

<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Sören Ehlers
<b>Language</b>	DE/EN
<b>Cycle</b>	SoSe
<b>Content</b>	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.
<b>Literature</b>	Script und ausgewählte Literature. Script and assorted literature.

**Course L1573: Special topics of ship structural design**

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

Module M1175: Special Topics of Ship Propulsion and 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
<b>Module Responsible</b>	Prof. Moustafa Abdel-Maksoud		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basic knowledge on ship resistance, ship propulsion and propeller theory		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i></p> <ul style="list-style-type: none"> <li>Understand present research questions in the field of ship propulsion</li> <li>Explain the present state of the art for the topics considered</li> <li>Apply given methodology to approach given problems</li> <li>Evaluate the limits of the present ship propulsion systems</li> <li>Identify possibilities to extend present methods and technologies</li> <li>Evaluate the feasibility of further developments</li> </ul> <p><i>Skills</i></p> <p>Students are able to</p> <ul style="list-style-type: none"> <li>select and apply suitable computing and simulation methods to determine the hydrodynamic characteristics of ship propulsion systems</li> <li>model the behavior of ship propulsion systems under different operation conditions by using simplified methods</li> <li>evaluate critically the investigation results of experimental or numerical investigations</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <p>Students are able to</p> <ul style="list-style-type: none"> <li>solve problems in heterogeneous groups and to document the corresponding results</li> <li>share new knowledge with group members</li> </ul> <p><i>Autonomy</i></p> <p>Students are able to assess their knowledge by means of exercises and case studies</p>		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	180 min		
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Moustafa Abdel-Maksoud
<b>Language</b>	DE/EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>Resistance components of different high speed water vehicles</li> <li>Propulsion units of high speed vehicles</li> <li>Waves resistance in shallow and deep water</li> <li>Surface effect ships (SES)</li> <li>Hydrofoil supported vehicles</li> <li>Semi-displacement vehicles</li> <li>Planning vehicles</li> <li>Slamming</li> <li>Manoeuvrability</li> </ol>
<b>Literature</b>	Faltinsen, O. M., Hydrodynamics of High-Speed Marine Vehicles, Cambridge University Press, UK, 2006

<b>Course L1589: Special Topics of Ship Propulsion</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Moustafa Abdel-Maksoud
<b>Language</b>	DE/EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Propeller Geometry</li> <li>2. Cavitation</li> <li>3. Model Tests, Propeller-Hull Interaction</li> <li>4. Pressure Fluctuation / Vibration</li> <li>5. Potential Theory</li> <li>6. Propeller Design</li> <li>7. Controllable Pitch Propellers</li> <li>8. Ducted Propellers</li> <li>9. Podded Drives</li> <li>10. Water Jet Propulsion</li> <li>11. Voith-Schneider-Propulsors</li> </ol>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Breslin, J., P., Andersen, P., Hydrodynamics of Ship Propellers, Cambridge Ocean Technology, Series 3, Cambridge University Press, 1996.</li> <li>• Lewis, V. E., ed., Principles of Naval Architecture, Volume II Resistance, Propulsion and Vibration, SNAME, 1988.</li> <li>• N. N., International Conference Waterjet 4, RINA London, 2004</li> <li>• N. N., 1st International Conference on Technological Advances in Podded Propulsion, Newcastle, 2004</li> </ul>

Module M0653: High-Performance Computing				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Fundamentals of High-Performance Computing (L0242)		Lecture	2	3
Fundamentals of High-Performance Computing (L1416)		Project-/problem-based Learning	2	3
<b>Module Responsible</b>	Prof. Thomas Rung			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Basic knowledge in usage of modern IT environment</li> <li>• Programming skills</li> </ul>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	Students are able to outline the fundamentals of numerical algorithms for high-performance computers by reference to modern hardware examples. Students can explain the relation between hard- and software aspects for the design of algorithms.			
<i>Knowledge</i>				
<i>Skills</i>	Student can perform a critical assesment of the computational efficiency of simulation approaches.			
<b>Personal Competence</b>	Students are able to develop and code algorithms in a team.			
<i>Social Competence</i>				
<i>Autonomy</i>				
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	None			
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	1.5h			
<b>Assignment for the Following Curricula</b>	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory			

Course L0242: Fundamentals of High-Performance Computing	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Thomas Rung
<b>Language</b>	DE/EN
<b>Cycle</b>	SoSe
<b>Content</b>	Fundamentals of modern hardware architectur, critical hard- & software aspects for efficient processing of exemplary algorithms, concepts for shared- and distributed-memory systems, implementations for accelerator hardware (GPGPUs)
<b>Literature</b>	1) Vortragsmaterialien und Problemanleitungen  2) G. Hager G. Wellein: Introduction to High Performance Computing for Scientists and Engineers CRC Computational Science Series, 2010

Course L1416: Fundamentals of High-Performance Computing	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Thomas Rung
<b>Language</b>	DE/EN
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0751: Vibration Theory				
Courses				
Title	Typ	Hrs/wk	CP	
Vibration Theory (L0701)	Integrated Lecture	4	6	
<b>Module Responsible</b>	Prof. Norbert Hoffmann			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Calculus</li> <li>• Linear Algebra</li> <li>• Engineering Mechanics</li> </ul>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b> <i>Knowledge</i>	<ul style="list-style-type: none"> <li>• Students are able to denote terms and concepts of Vibration Theory and develop them further.</li> <li>• Students know methods of modeling and simulation for free, driven, self-excited and parameter driven vibrations.</li> <li>• Students know about concepts of linear and nonlinear vibration problems.</li> <li>• Students know basic tasks of vibration problems of discrete and continuous systems.</li> </ul>			
<i>Skills</i>	<ul style="list-style-type: none"> <li>• Students are able to denote methods of Vibration Theory and develop them further.</li> <li>• Students are able to apply and expand methods of modeling and simulation for free, forced, self-excited and parameter driven vibrations.</li> <li>• Students are able to solve linear and nonlinear vibration problems.</li> </ul>			
<b>Personal Competence</b> <i>Social Competence</i>	<ul style="list-style-type: none"> <li>• Students can analyze vibration problems, work on them, and reach working results also in teams or groups.</li> <li>• Students are able to document the results of vibration studies also in groups.</li> </ul>			
<i>Autonomy</i>	<ul style="list-style-type: none"> <li>• Students are able to individually analyze and solve vibration problems.</li> <li>• Students are able to approach individually research tasks in Vibration Theory.</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	None			
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	2 Hours			
<b>Assignment for the Following Curricula</b>	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			

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<b>Course L0701: Vibration Theory</b>	
<b>Typ</b>	Integrated Lecture
<b>Hrs/wk</b>	4
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
<b>Lecturer</b>	Prof. Norbert Hoffmann
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Linear and Nonlinear Single and Multiple Degree of Freedom Vibrations</p> <ul style="list-style-type: none"> <li>• Free vibration</li> <li>• Self-excited vibration</li> <li>• Parameter driven vibration</li> <li>• Forced vibration</li> <li>• Multi degree of freedom vibration</li> <li>• Continuum vibration</li> <li>• Irregular vibration</li> </ul>
<b>Literature</b>	<p>German - K. Magnus, K. Popp, W. Sextro: Schwingungen. Physikalische Grundlagen und mathematische Behandlung von Schwingungen.</p> <p>English - K. Magnus: Vibrations.</p>

Module M1157: Marine Auxiliaries				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
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
<b>Module Responsible</b>	Prof. Christopher Friedrich Wirz			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>				
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students are able to <ul style="list-style-type: none"> <li>• name the operating behaviour of consumers,</li> <li>• 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,</li> <li>• explain power generation and distribution in isolated grids, wave generator systems on ships,</li> <li>• name requirements for network protection, selectivity and operational monitoring,</li> <li>• name the requirements regarding marine equipment and apply to product development, as well as</li> <li>• describe operating procedures of equipment components of standard and specialized ships and derive requirements for product development.</li> </ul>			
<i>Skills</i>	Students are able to <ul style="list-style-type: none"> <li>• calculate short-circuit currents, switchgear,</li> <li>• design electrical propulsion systems for ships</li> <li>• design additional machinery components, as well as</li> <li>• to apply basic principles of hydraulics and to develop hydraulic systems.</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	The students are able to communicate and cooperate in a professional environment in the shipbuilding and component supply industry.			
<i>Autonomy</i>	The widespread scope of gained knowledge enables the students to handle situations in their future profession independently and confidently.			
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84			
<b>Credit points</b>	6			
<b>Course achievement</b>	None			
<b>Examination</b>	Oral exam			
<b>Examination duration and scale</b>	20 min			
<b>Assignment for the Following Curricula</b>	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory			

Course L1531: Electrical Installation on Ships	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Günter Ackermann
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• performance in service of electrical consumers.</li> <li>• 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.</li> <li>• power generation and distribution in isolated networks, shaft generators for ships</li> <li>• calculation of short circuits and behaviour of switching devices</li> <li>• protective devices, selectivity monitoring</li> <li>• electrical Propulsion plants for ships</li> </ul>
<b>Literature</b>	H. Meier-Peter, F. Bernhardt u. a.: Handbuch der Schiffsbetriebstechnik, Seehafen Verlag  (engl. Version: "Compendium Marine Engineering")  Gleiß, Thamm: Schiffselektrotechnik, VEB Verlag Technik Berlin

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

Course L1249: Auxiliary Systems on Board of Ships	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Christopher Friedrich Wirz
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Vorschriften zur Schiffsausrüstung</li> <li>• Ausrüstungsanlagen auf Standard-Schiffen</li> <li>• Ausrüstungsanlagen auf Spezial-Schiffen</li> <li>• Grundlagen und Systemtechnik der Hydraulik</li> <li>• Auslegung und Betrieb von Ausrüstungsanlagen</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• H. Meyer-Peter, F. Bernhardt: Handbuch der Schiffsbetriebstechnik</li> <li>• H. Watter: Hydraulik und Pneumatik</li> </ul>

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



Module M1166: Advanced Ship Design				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Advanced Ship Design (L1567)		Lecture	2	4
Advanced Ship Design (L1710)		Recitation Section (large)	2	2
<b>Module Responsible</b>	Prof. Stefan Krüger			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Ship Design, Hydrostatics, Ship Safety, Resistance and Propulsion			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The most important design problems, constraints and methods related to the a.m. ship types 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 double ended ferries.			
<i>Skills</i>	Der Student soll die in Schiffsentwurf I erworbenen Kenntnisse und das zugehörige Methodenwissen konkret an bestimmten Trockenfrachtern sowie an Passagierschiffen vertiefen. Am Ende der Vorlesung wird erwartet, dass der Student in der Lage ist, elementare Schiffsentwürfe durchführen zu können.			
<b>Personal Competence</b>				
<i>Social Competence</i>	The student learns to make technical decisions and to get acceptance for his decisions.			
<i>Autonomy</i>	Autonomous Elaboration of Design Information.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	None			
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	180 min			
<b>Assignment for the Following Curricula</b>	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory			

Course L1567: Advanced Ship Design	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 92, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Stefan Krüger
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	The most important design problems, constraints and methods related to the a.m. ship types 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 double ended ferries.
<b>Literature</b>	Schneekluth, Entwerfen von Schiffen

Course L1710: Advanced Ship Design	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Stefan Krüger
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

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	
<b>Module Responsible</b>	Prof. Alexander Düster			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Knowledge of partial differential equations is recommended.			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i> Students are able to</p> <ul style="list-style-type: none"> <li>+ give an overview of the different nonlinear phenomena in structural mechanics.</li> <li>+ explain the mechanical background of nonlinear phenomena in structural mechanics.</li> <li>+ to specify problems of nonlinear structural analysis, to identify them in a given situation and to explain their mathematical and mechanical background.</li> </ul> <p><i>Skills</i> Students are able to</p> <ul style="list-style-type: none"> <li>+ model nonlinear structural problems.</li> <li>+ select for a given nonlinear structural problem a suitable computational procedure.</li> <li>+ apply finite element procedures for nonlinear structural analysis.</li> <li>+ critically verify and judge results of nonlinear finite elements.</li> <li>+ to transfer their knowledge of nonlinear solution procedures to new problems.</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students are able to</p> <ul style="list-style-type: none"> <li>+ solve problems in heterogeneous groups.</li> <li>+ present and discuss their results in front of others.</li> <li>+ give and accept professional constructive criticism.</li> </ul> <p><i>Autonomy</i> Students are able to</p> <ul style="list-style-type: none"> <li>+ assess their knowledge by means of exercises and E-Learning.</li> <li>+ acquaint themselves with the necessary knowledge to solve research oriented tasks.</li> <li>+ to transform the acquired knowledge to similar problems.</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	None			
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 min			
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Alexander Düster
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Nonlinear phenomena</li> <li>3. Mathematical preliminaries</li> <li>4. Basic equations of continuum mechanics</li> <li>5. Spatial discretization with finite elements</li> <li>6. Solution of nonlinear systems of equations</li> <li>7. Solution of elastoplastic problems</li> <li>8. Stability problems</li> <li>9. Contact problems</li> </ol>
<b>Literature</b>	<p>[1] Alexander Düster, Nonlinear Structural Analysis, Lecture Notes, Technische Universität Hamburg-Harburg, 2014.</p> <p>[2] Peter Wriggers, Nonlinear Finite Element Methods, Springer 2008.</p> <p>[3] Peter Wriggers, Nichtlineare Finite-Elemente-Methoden, Springer 2001.</p> <p>[4] Javier Bonet and Richard D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, Cambridge University Press, 2008.</p>

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

Module M1178: Manoeuvrability and Shallow Water Ship Hydrodynamics			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b> <b>CP</b>
Manoeuvrability of Ships (L1597)		Lecture	2                  3
Shallow Water Ship Hydrodynamics (L1598)		Lecture	2                  3
<b>Module Responsible</b>	Prof. Moustafa Abdel-Maksoud		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	B.Sc. Schiffbau		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i></p> <p>The students learn the motion equation and how to describe hydrodynamic forces. They'll 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.</p> <p>Furthermore, the students learn the basics of assessment and prognosis of ship manoeuvrability. Basics of characteristics of flows around ships in shallow water regarding ship propulsion and manoeuvrability will be acquired.</p> <p><i>Skills</i></p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <p><i>Autonomy</i></p>		
<b>Workload in Hours</b>			
<b>Credit points</b>			
<b>Course achievement</b>			
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	180 min		
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Moustafa Abdel-Maksoud
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• coordinates &amp; degrees of freedom</li> <li>• governing equations of motion</li> <li>• hydrodynamic forces &amp; moments</li> <li>• ruder forces</li> <li>• navigation based on linearised eq. of motion (exemplary solutions, yaw stability)</li> <li>• manoeuvring test (constraint &amp; unconstraint motion)</li> <li>• slender body approximation</li> </ul> <p><b>Learning Outcomes</b></p> <p>Introduction into basic concepts for the assessment and prognosis ship manoeuvrability.</p> <p>Ability to develop methods for analysis of manoeuvring behaviour of ships.</p>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Crane, C. L. H., Eda, A. L., Principles of Naval Architecture, Chapter 9, Controllability, SNAME, New York, 1989</li> <li>• Brix, J., Manoeuvring Technical Manual, Seehafen Verlag GmbH, Hamburg 1993</li> <li>• Söding, H., Manövrieren, Vorlesungsmanskript, Institut für Fluidodynamik und Schiffstheorie, TUHH, Hamburg, 1995</li> </ul>

<b>Course L1598: Shallow Water Ship Hydrodynamics</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Moustafa Abdel-Maksoud, Dr. Norbert Stuntz
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Special Aspects of Shallow Water Hydrodynamics, Vertical and Horizontal Constraints, Irregularities in Channel Bed</li> <li>• Fundamental Equations of Shallow Water Hydrodynamics</li> <li>• Approximation of Shallow Water Waves, Boussinesq's Approximation</li> <li>• Ship Waves in Deep Water and under critical, non-critical and supercritical Velocities</li> <li>• Solitary Wves, Critical Speed Range, Extinction of Waves</li> <li>• Aspects of Ship motions in Canals with limited water depth</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• PNA (1988): Principle of Naval Architecture, Vol. II, ISBN 0-939773-01-5</li> <li>• Schneekluth (1988): Hydromechanik zum Schiffsentwurf</li> <li>• Jiang, T. (2001): Ship Waves in Shallow Water, Fortschritt-Berichte VDI, Series 12, No 466, ISBN 3-18-346612-0</li> </ul>

Module M0658: Innovative CFD Approaches				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
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
<b>Module Responsible</b>	Prof. Thomas Rung			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	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.			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	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.			
<i>Knowledge</i>				
<i>Skills</i>	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.			
<b>Personal Competence</b>	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.			
<i>Social Competence</i>				
<i>Autonomy</i>	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.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	20 %	Written elaboration	
<b>Examination</b>	Oral exam			
<b>Examination duration and scale</b>	30 min			
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Thomas Rung
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	Computational Optimisation, Parallel Computing, Efficient CFD-Procedures for GPU Architectures, Alternative Approximations (Lattice-Boltzmann Methods, Particle Methods), Fluid/Structure-Interaction, Modelling of Hybrid Continua
<b>Literature</b>	Vorlesungsmaterialien /lecture notes

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

Module M1147: Research Project Naval Architecture and Ocean Engineering	
Courses	
Title	Typ
Hrs/wk	CP
<b>Module Responsible</b>	Dozenten des Studiengangs
<b>Admission Requirements</b>	None
<b>Recommended Previous Knowledge</b>	Subjects of the Master program and the specialisations.
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b> <i>Knowledge</i> <ul style="list-style-type: none"> <li>Students can explain the project as well as their autonomously gained knowledge and relate it to current issues of their field of study.</li> <li>They can explain the basic scientific methods they have worked with.</li> </ul> <i>Skills</i> <p>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.</p> <b>Personal Competence</b> <i>Social Competence</i> <p>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.</p> <i>Autonomy</i> <p>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.</p>	
<b>Workload in Hours</b>	Independent Study Time 360, Study Time in Lecture 0
<b>Credit points</b>	12
<b>Course achievement</b>	None
<b>Examination</b>	Study work
<b>Examination duration and scale</b>	according to FSPO
<b>Assignment for the Following Curricula</b>	Naval Architecture and Ocean Engineering: Core Qualification: Compulsory



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
<b>Module Responsible</b>	Prof. Sören Ehlers		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	none		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> The challenges and requirements due to ice can be explained. Ice loads can be explained and ice strengthening can be understood.</p> <p><i>Skills</i> 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.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students are capable to present their structural design and discuss their decisions constructively in a group.</p> <p><i>Autonomy</i> 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.</p>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Oral exam		
<b>Examination duration and scale</b>	30 min		
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Walter Kuehnlein
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Ice, Ice Properties, Ice Failure Modes and Challenges and Requirements due to Ice               <ul style="list-style-type: none"> <li>◦ Introduction, what is/means ice engineering</li> <li>◦ Description of different kinds of ice, main ice properties and different ice failure modes</li> <li>◦ Why is ice so different compared to open water</li> <li>◦ Presentation of design challenges and requirements for structures and systems in ice covered waters</li> </ul> </li> <li>2. Ice Load Determination and Ice Model Testing               <ul style="list-style-type: none"> <li>◦ Overview of different empirical equations for simple determination of ice loads</li> <li>◦ Discussion and interpretation of the different equations and results</li> <li>◦ Introduction to ice model tests</li> <li>◦ What are the requirements for ice model tests, what parameters have to be scaled</li> <li>◦ What can be simulated and how to use the results of such ice model tests</li> </ul> </li> <li>3. Computational Modelling of Ice-Structure Interaction Processes               <ul style="list-style-type: none"> <li>◦ Dynamic fracture and continuum mechanics for modelling ice-structure interaction processes</li> <li>◦ Alternative numerical crack propagation modelling methods. Examples of cohesive element models for real life structures.</li> <li>◦ Discussion of contribution of ice properties, hydrodynamics and rubble.</li> </ul> </li> <li>4. Ice Design Philosophies and Perspectives               <ul style="list-style-type: none"> <li>◦ What has to be considered when designing structures or systems for ice covered waters</li> <li>◦ What are the main differences compared to open water design</li> <li>◦ Ice Management</li> <li>◦ What are the main ice design philosophies and why is an integrated concept so important for ice</li> </ul> </li> </ol> <p><b>Learning Objectives</b></p> <p>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.</p>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Proceedings OMAE</li> <li>• Proceedings POAC</li> <li>• Proceedings ATC</li> </ul>

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

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

Module M1240: Fatigue Strength of Ships and Offshore Structures			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b> <b>CP</b>
Fatigue Strength of Ships and Offshore Structures (L1521)		Lecture	2              3
Fatigue Strength of Ships and Offshore Structures (L1522)		Recitation Section (small)	2              3
<b>Module Responsible</b>	Prof. Sören Ehlers		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Structural analysis of ships and/or offshore structures and fundamental knowledge in mechanics and mechanics of materials		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students are able to</p> <ul style="list-style-type: none"> <li>describe fatigue loads and stresses, as well as</li> <li>describe structural behaviour under cyclic loads.</li> </ul> <p><i>Skills</i> Students are able to calculate life prediction based on the S-N approach as well as life prediction based on the crack propagation.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> The students are able to communicate and cooperate in a professional environment in the shipbuilding and component supply industry.</p> <p><i>Autonomy</i> The widespread scope of gained knowledge enables the students to handle situations in their future profession independently and confidently.</p>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Oral exam		
<b>Examination duration and scale</b>	30 min		
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Wolfgang Fricke
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	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 constant 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
<b>Literature</b>	Siehe Vorlesungsskript

<b>Course L1522: Fatigue Strength of Ships and Offshore Structures</b>	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Wolfgang Fricke
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	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
<b>Module Responsible</b>	Prof. Norbert Hoffmann		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Calculus, Algebra, Engineering Mechanics, Vibrations.		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b> <i>Knowledge</i>  <i>Skills</i>  <b>Personal Competence</b> <i>Social Competence</i>  <i>Autonomy</i>	<ul style="list-style-type: none"> <li>• Students are able to reflect existing terms and concepts in Wave Mechanics</li> <li>• Students are able to identify and express the need to develop and research new terms and concepts.</li> <li>• Students are able to apply existing research methods and procedures of wave mechanics.</li> <li>• Students are able to develop novel research methods and procedures in wave mechanics.</li> <li>• Students can reach working results also in groups.</li> <li>• Students can present and communicate working results also in groups.</li> <li>• Students are able to approach given research tasks individually.</li> <li>• Students are able to identify and follow up novel research tasks by themselves.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	2 Hours		
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	4
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
<b>Lecturer</b>	Prof. Norbert Hoffmann
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Introduction into the Dynamics of Linear and Nonlinear Waves</p> <ul style="list-style-type: none"> <li>• Linear Waves <ul style="list-style-type: none"> <li>◦ Dispersion</li> <li>◦ Phase and Group Velocity</li> <li>◦ Envelopes</li> <li>◦ Discrete Systems</li> </ul> </li> <li>• Nonlinear Waves <ul style="list-style-type: none"> <li>◦ Model Equations</li> <li>◦ Solitons, Breathers, Extreme Waves</li> </ul> </li> <li>• Water Waves, Ocean Waves <ul style="list-style-type: none"> <li>◦ Airy and Stokes</li> <li>◦ Natural Sea State</li> <li>◦ Kinetic Modelling</li> </ul> </li> <li>• Other topics</li> </ul>
<b>Literature</b>	<p>F.K. Kneubühl: Oscillations and Waves. Springer.</p> <p>G.B. Witham, Linear and Nonlinear Waves. Wiley.</p> <p>C.C. Mei, Theory and Applications of Ocean Surface Waves. World Scientific.</p> <p>L.H. Holthuijsen, Waves in Oceanic and Coastal Waters. Cambridge.</p> <p>And others.</p>

## 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
<b>Module Responsible</b>	Professoren der TUHH		
<b>Admission Requirements</b>	<ul style="list-style-type: none"> <li>• According to General Regulations §21 (1): At least 60 credit points have to be achieved in study programme. The examinations board decides on exceptions.</li> </ul>		
<b>Recommended Previous Knowledge</b>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<i>Knowledge</i>		

# Module Manual M.Sc. "Naval Architecture and Ocean Engineering"

<p><b>Personal Competence</b></p> <p><i>Skills</i></p> <p><i>Social Competence</i></p> <p><i>Autonomy</i></p>	<ul style="list-style-type: none"> <li>• The students can use specialized knowledge (facts, theories, and methods) of their subject competently on specialized issues.</li> <li>• 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.</li> <li>• The students can place a research task in their subject area in its context and describe and critically assess the state of research.</li> </ul> <p>The students are able:</p> <ul style="list-style-type: none"> <li>• To select, apply and, if necessary, develop further methods that are suitable for solving the specialized problem in question.</li> <li>• 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.</li> <li>• To develop new scientific findings in their subject area and subject them to a critical assessment.</li> </ul> <p>Students can</p> <ul style="list-style-type: none"> <li>• Both in writing and orally outline a scientific issue for an expert audience accurately, understandably and in a structured way.</li> <li>• 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.</li> </ul> <p>Students are able:</p> <ul style="list-style-type: none"> <li>• To structure a project of their own in work packages and to work them off accordingly.</li> <li>• To work their way in depth into a largely unknown subject and to access the information required for them to do so.</li> <li>• To apply the techniques of scientific work comprehensively in research of their own.</li> </ul>
<b>Workload in Hours</b>	Independent Study Time 900, Study Time in Lecture 0
<b>Credit points</b>	30
<b>Course achievement</b>	None
<b>Examination</b>	Thesis
<b>Examination duration and scale</b>	According to General Regulations
<b>Assignment for the Following Curricula</b>	<p>Civil Engineering: Thesis: Compulsory</p> <p>Bioprocess Engineering: Thesis: Compulsory</p> <p>Chemical and Bioprocess Engineering: Thesis: Compulsory</p> <p>Computer Science: Thesis: Compulsory</p> <p>Electrical Engineering: Thesis: Compulsory</p> <p>Energy Systems: Thesis: Compulsory</p> <p>Environmental Engineering: Thesis: Compulsory</p> <p>Aircraft Systems Engineering: Thesis: Compulsory</p> <p>Global Innovation Management: Thesis: Compulsory</p> <p>Computer Science in Engineering: Thesis: Compulsory</p> <p>Information and Communication Systems: Thesis: Compulsory</p> <p>Interdisciplinary Mathematics: Thesis: Compulsory</p> <p>International Production Management: Thesis: Compulsory</p> <p>International Management and Engineering: Thesis: Compulsory</p> <p>Joint European Master in Environmental Studies - Cities and Sustainability: Thesis: Compulsory</p> <p>Logistics, Infrastructure and Mobility: Thesis: Compulsory</p> <p>Materials Science: Thesis: Compulsory</p> <p>Mechanical Engineering and Management: Thesis: Compulsory</p> <p>Mechatronics: Thesis: Compulsory</p> <p>Biomedical Engineering: Thesis: Compulsory</p> <p>Microelectronics and Microsystems: Thesis: Compulsory</p> <p>Product Development, Materials and Production: Thesis: Compulsory</p> <p>Renewable Energies: Thesis: Compulsory</p> <p>Naval Architecture and Ocean Engineering: Thesis: Compulsory</p> <p>Ship and Offshore Technology: Thesis: Compulsory</p> <p>Teilstudiengang Lehramt Metalltechnik: Thesis: Compulsory</p> <p>Theoretical Mechanical Engineering: Thesis: Compulsory</p> <p>Process Engineering: Thesis: Compulsory</p> <p>Water and Environmental Engineering: Thesis: Compulsory</p> <p>Certification in Engineering &amp; Advisory in Aviation: Thesis: Compulsory</p>