Curriculum for the Master's Program in Structural and Civil Engineering

The Faculties of Engineering, Science and Medicine
Aalborg University, Esbjerg
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dekan

Preface:
Pursuant to Act 985 of October 21, 2009 on Universities (the University Act) with subsequent changes, the following curriculum for the Master's program in Structural and Civil Engineering is stipulated. The program also follows the Framework Provisions and the Examination Policies and Procedures for the Faculties of Engineering, Science and Medicine.

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Chapter 1: Legal Basis of the Curriculum, etc.

1.1 Basis in ministerial orders

The Master's program in Structural and Civil Engineering is organized in accordance with the Ministry of Science, Technology and Innovation's Ministerial Order no. 338 of May 6, 2004 on Bachelor's and Master's Programs at Universities (the Ministerial Order of the Study Programs) and Ministerial Order no. 867 of August 19, 2004 on University Examinations (the Examination Order) with subsequent changes. Further reference is made to Ministerial Order no. 181 of February 23, 2010 (the Admission Order) and Ministerial Order no. 250 of March 15, 2007 (the Grading Scale Order) with subsequent changes.

1.2 Faculty affiliation

The Master's program falls under the Faculties of Engineering, Science and Medicine, Aalborg University.

1.3 Board of Studies affiliation

The Master's program falls under the Study Board of Civil Engineering in the School of Engineering and Science.

Chapter 2: Admission, Degree Designation, Program Duration and Competence Profile

2.1 Admission

Admission to the Master's program in Structural and Civil Engineering requires a Bachelor's degree in Structural and Civil Engineering or the like.

Students with another Bachelor's degree, upon application to the Board of Studies, will be admitted after a specific academic assessment if the applicant is deemed to have comparable educational prerequisites. The University can stipulate requirements concerning conducting additional exams prior to the start of study.

Basic knowledge at BSc level must be documented within the following fields:

- structural behavior under static loading,
- construction materials, including concrete, steel and timber,
- continuum mechanics related to solids and fluids,
- soil mechanics, consolidation and groundwater flow,
- foundations and earth-retaining structures,
- hydraulics, including flow in pipes and open channels.

Further, applicants must be familiar with:

- communication (oral and written) in English,
- physics, including energy, momentum and basic thermo dynamics,

· linear algebra, including determination of eigenvalues,

· analytical and numerical solution of ordinary and partial differential equations,

· statistics and probability.

Finally, familiarity with word processing, computer aided design and engineering as well as computer programming is an advantage.

2.2 Degree designation in Danish and English
The Master's program entitles the graduate to the designation civilingeniør, cand.polyt. (candidatus/candidata polytechnices) i bygge- og anlægskonstruktion. The English designation is: Master of Science (MSc) in Engineering (Structural and Civil Engineering).

2.3 The program's specification in ECTS credits
The Master's program is a 2-year, research-based, full-time study program. The program is set to 120 ECTS credits.

2.4 Competence profile on the diploma
The following competence profile will appear on the diploma:

> A graduate of the Master's program has competencies acquired through an educational program that has taken place in a research environment.
>
> The graduate of the Master's program can perform highly qualified functions on the labor market on the basis of the educational program. Moreover, the graduate has prerequisites for research (a Ph.D. program). Compared to the Bachelor's degree, the graduate of the Master's program has developed her/his academic knowledge and independence, so that the graduate can independently apply scientific theory and method in both an academic and occupational/professional context.

2.5 Competence profile of the program

<u>The graduate of the Master's program:</u>

Knowledge:

- Has scientifically based knowledge about the structural behaviour of civil engineering structures regarding the static as well as the dynamic response
- Has an understanding of geotechnical engineering and hydraulics as well as structure-soil and structure-fluid interaction based on scientific methods
- Must understand analytical, numerical and experimental methods for analysis and design of engineering structures
- Has knowledge about construction materials and soil regarding their mechanical behaviour and modeling
- Has knowledge about loads, especially environmental loads like wind and wave loads, and methods for their evaluation

- Has knowledge about risk and reliability in engineering including uncertainties of loads, geometry, material properties, structural response and computational models
- Has knowledge in one or more subject areas that is based on the highest international research within the fields of civil and structural engineering.

Skills:

- Excels in the scientific methods and tools as well as general skills related to employment within civil and structural engineering
- Can communicate research-based knowledge and discuss professional and scientific problems with peers as well as non-specialists, using the correct terminology in civil engineering
- Can apply appropriate methods of analysis for investigating civil engineering structures and construction materials
- Can assess loads on civil engineering structures, including environmental loading from wind and waves
- Can assess the uncertainty connected with structural analysis, and judge the quality of the results
- Can select and apply appropriate computational and experimental methods to investigate the static and dynamic response of civil engineering structures
- Can apply experimental tests for obtaining material properties, calibrating computational models and assess uncertainties within the fields of structural and geotechnical engineering.

Competencies

- Can select and apply appropriate methods for solving a given problem within civil engineering and judge the results regarding their accuracy and validity
- Can identify scientific problems within civil and structural engineering and select and apply proper scientific theories, methods and tools for their solution
- Can develop and advance new analyses and solutions within civil and structural engineering
- Can manage work-related situations that are complex and unpredictable, and which require new solutions
- Can initiate and implement discipline-specific as well as interdisciplinary cooperation and assume professional responsibility
- Can take responsibility for own professional development and specialization.

Chapter 3: Content and Organization of the Program

The program is structured in modules and organized as a problem-based study. A module is a program element or a group of program elements, which aims to give students a set of professional skills within a fixed time frame specified in ECTS credits, and concluding with one or more examinations within specific exam periods that are defined in the curriculum.

The program is based on a combination of academic, problem-oriented and interdisciplinary approaches and organized based on the following work and evaluation methods that combine skills

and reflection:

- project work
- lectures
- classroom instructions
- study groups
- workshop
- exercises
- laboratory tests
- measurements and testing in the field
- portfolio work
- independent study

The modules are evaluated either through written or oral exams as started in the description of the modules in the Appendix.

For individual written exams the study board selects among the following possibilities:

- Ordinary written exam based on handed out exercises
- multiple choice
- ongoing evaluation of written assignments

For individual oral exams the study board selects among the following possibilities:

- Ordinary oral exam with or without preparation
- oral exam based on project report
- oral exam based on presentation seminar
- portfolio based oral exam

If the number of students following a module is small and/or if the number of students having to attend a re-exam is small the study board can decide that an exam is conducted either as an oral or written individual exam for economic reasons. In the first case decision must be notified before the start of the teaching activity in the latter case the students must be notified when the examination date is decided.

3.1 Overview of the program

All modules are assessed through individual grading according to the 7-point scale *or* Pass/Fail. All modules are assessed by external examination (external grading) or internal examination (internal grading or by assessment by the supervisor only).

Of a total of 120 ECTS, 80-110 ECTS are assessed by the 7-point scale and 45-75 ECTS are assessed by external examination.

Semester		Module	ECTS	Assessment	Exam
1st		Analysis and Design of Load-Bearing Structures	15	7-point scale	Internal
		Structural Mechanics and Dynamics	5	7-point scale	Internal
		Material Modelling in Civil Engineering	5	7-point scale	Internal
		Fluid and Water Wave Dynamics	5	7-point scale	Internal
2nd		The Excitation and Foundation of Marine Structures	15	7-point scale	External
		Coastal, Offshore and Port Engineering	5	Pass/Fail	Internal
		Advanced Structural Engineering	5	Pass/Fail	Internal
		Risk and Reliability in Engineering	5	7-point scale	Internal
3rd		Analysis and Solution of an Advanced Civil and/or Structural Engineering Problem	15	Pass/Fail	Internal
	A	Renewable Energy Structures: Wind Turbines and Wave Energy Devices[1)]	5	Pass/Fail	Internal
		Wind Loads on Structures[1)]	5	Pass/Fail	Internal
		Advanced Geotechnical Engineering[1)]	5	Pass/Fail	Internal
		Fracture Mechanics and Fatigue[1)]	5	Pass/Fail	Internal
	B	Traineeship at an Engineering Company[2)]	30	Pass/Fail	Internal
	C	Study at Other University	30	-[3)]	-[3)]
	D	Long Master's Thesis	30	-[4)]	-[4)]
4th		Master's Thesis	30	7-point scale	External
Total			120		

1) The student must choose three out of the four course modules. The modules will not be given with a small number of students.
2) The study board must approve on the content of the Traineeship, before it is commenced.
3) Assessment and exam according to the curriculum at the other university. The study board must approve on the contents before the study is commenced.
4) See module description for Master's thesis. By Long Master's Thesis the Master's Thesis is made at the 3rd and 4th semester and is 60 ECTS.

The students are given options in the project modules as they can select among different projects within the same general theme. Moreover, the projects on the 3rd and 4th semester can be selected freely within the field of Structural engineering and the students have the choice of making a long master's thesis comprising both semesters.

The study board of civil engineering can decide, that the contents of a course module on a semester is taught in the project module in the same semester, by increasing the ECTS extend of the project module by the same number of ECTS. The decision is taken regarding to capacity and/or economy.

3.2 Module descriptions

Descriptions of the modules of the education are inserted at the back, ordered alphabetically after their English title.

Chapter 4: Entry into Force, Interim Provisions and Revision

The curriculum is approved by the Dean of the Faculties of Engineering, Science and Medicine and enters into force as of 1 September 2010.

Students who wish to complete their studies under the previous curriculum from 2009 must conclude their education by the summer examination period 2013 at the latest, since examinations under the previous curriculum are not offered after this time.

In accordance with the Framework Provisions and the Handbook on Quality Management for the Faculties of Engineering, Science and Medicine at Aalborg University, the curriculum must be revised no later than 5 years after its entry into force.

Chapter 5: Other Provisions

5.1 Rules concerning written work, including the Master's thesis

In the assessment of all written work, regardless of the language it is written in, weight is also given to the student's spelling and formulation ability, in addition to the academic content. Orthographic and grammatical correctness as well as stylistic proficiency are taken as a basis for the evaluation of language performance. Language performance must always be included as an independent dimension of the total evaluation. However, no examination can be assessed as 'Pass' on the basis of language performance alone; similarly, an examination normally cannot be assessed as 'Fail' on the basis of poor language performance alone.
The Board of Studies can grant exemption from this in special cases (e.g., dyslexia or a native language other than Danish).

The Master's thesis must include an English summary.[1] If the project is written in English, the summary must be in Danish.[2] The summary must be at least 1 page and not more than 2 pages. The summary is included in the evaluation of the project as a whole.

5.2 Rules concerning credit transfer (*merit*), including the possibility for choice of modules that are part of another program at a university in Denmark or abroad

In the individual case, the Board of Studies can approve successfully completed (passed) program elements from other Master's programs in lieu of program elements in this program (credit transfer). The Board of Studies can also approve successfully completed (passed) program elements from another Danish program or a program outside of Denmark at the same level in lieu of program elements within this curriculum. Decisions on credit transfer are made by the Board of Studies based on an academic assessment. See the Framework Provisions for the rules on credit transfer.

5.3 Rules for examinations

The rules for examinations are stated in the Examination Policies and Procedures published by the Faculties of Engineering, Science and Medicine on their website.

[1] Or another foreign language (upon approval from the Board of Studies).
[2] The Board of Studies can grant exemption from this.

5.4 Exemption
In exceptional circumstances, the Board of Studies study can grant exemption from those parts of the curriculum that are not stipulated by law or ministerial order. Exemption regarding an examination applies to the immediate examination.

5.5 Additional information
The current version of the curriculum is published on the Board of Studies' website, including more detailed information about the program, including exams.

5.6 Completion of the Master's program
The Master's program must be completed no later than four years after it was begun.

5.7 Rules and requirements concerning the reading of texts in foreign languages and a statement of the foreign language knowledge this assumes
It is assumed that the student can read academic texts in modern Danish, Norwegian, Swedish and English and use reference works, etc., in other European languages.

Appendix: Module Descriptions

Advanced Geotechnical Engineering
Videregående funderingsanalyse

Prerequisites: The course modules: Material modelling in civil engineering; Advanced soil Mechanics

Objective: Students who complete the module:

Knowledge:

- Understand and use numerical methods, e.g. finite element method, to analyse soil-structure interaction problems for various geotechnical structures.
- Establish model for analysis of excavations and tunnel construction in urban areas.
- Have knowledge about common types of excavations, tunnels and problems related to the construction works.
- Finite-element analysis of wave propagation from earthquake, pile driven and traffic.
- Cyclic response and liquefaction of soil

Skills:

- To analyse and design complex geotechnical structures
- To understand the basis of, and to use (with computers) numerical methods to solve deformation and failure problems for selected geotechnical structures.

Competencies:

- Application of proper terminology in oral, written and graphical communication and documentation within geotechnical engineering

Type of instruction: Lectures, etc. supplemented with project work, workshops, presentation seminars, lab tests

Exam format: Individual oral or written exam. Exam format is decided on by start of semester.

Evaluation criteria: Are stated in the Framework Provisions.

Advanced Structural Engineering
Avancerede konstruktionsanalyser

Prerequisites: Corresponding to having passed the first semester
Objective: Students who complete the module:

Knowledge:

- Should have basic knowledge about non-linear effects in structural response, i.e. influence of large displacements, plasticity or other non-linear material behavior and dynamic effects.
- Should have knowledge about advanced structural analysis and its applications in engineering.
- Should have knowledge about non-linear behavior of thin-walled structures i.e. buckling and postbuckling behavior and influence of geometric imperfections.
- Should have knowledge of modeling joints in structures linear as well as non-linear.
- Should have knowledge about non-linear Finite Element analysis of thin-walled structures.

Skills:

- Should be able to formulate a mechanical/matematical model for structures behaving non-linearly.
- Should be able to formulate geometrically non-linear models for thin-walled structures involving buckling, postbuckling and imperfection sensitivity.
- Should be able to estimate the stability load for simplified thin-walled structures based on analytical models.
- Should be able to formulate mechanical/mathematical models for joints in structures e.g. flexible joints in frame structures.
- Should have sufficient background to choose an appropriate numerical model i.e. type of element and type of non-linear solution algorithm.
- Should be able to analyze a structure/structural component by a non-linear Finite Element code
- Should be able to verify the numerical results from Finite Element calculations by analytical models or other simplified models.
- Should be able to interpret the results from a non-linear Finite Element calculation

Competencies:

- Should be able to participate in non-linear analysis of engineering structures and participate in a dialog on structural modifications in order to improve the structural response.
- Should be able to model and analyze thin-walled structures with geometric non-linear behavior and participate in a dialog of non-linear analysis of other structures.

Type of instruction: Lectures, etc. supplemented with project work, workshops, presentation seminars, lab tests.

Exam format: Individual oral or written exam. Exam format is decided on by start of semester.

Evaluation criteria: Are stated in the Framework Provisions.

Analysis and Design of Load-Bearing Structures
Styrke og stivhedsanalyse af bærende konstruktioner

Prerequisites: A BSc degree in Civil Engineering, Structural Engineering or similar.

Objective: Students who complete the module:

Knowledge:

- Know fundamental theories and methods for analysis of structures subject to static loads
- Understand the behaviour of structures subject to static loading regarding their deformation and carrying capacity
- Understand the solution procedure in Finite Element Analysis of linear elastic static problems
- Have a basic knowledge and understanding of experimental work, including test planning, test conduction, different types of test equipment, modelling of uncertainties and comparison of model and test results using statistical methods

Skills:

- Use the correct terminology for structural analysis and design
- Be able to apply analytical solution methods based on continuum mechanics for selected static problems
- Be able to develop and implement a Finite Element software code for analysis of a selected simple structure subject to static loading
- Be able to use a commercial Finite Element code for analysing a given static structural problem
- Be able to plan and set up a test for determining basic material properties
- Be able to plan and set up a test for finding the strength and stiffness of a given structure
- Be able to apply statistical methods for assessment of test results

Competencies:

- Be able to select appropriate analysis methods for a given structural problem, including analytical, numerical and experimental analysis methods
- Be able to compare results obtained from different analysis methods and be able to judge the quality of the results
- Be able to quantify errors associated with different types of analysis and evaluate the methods regarding assumptions and simplifications
- Must be able to communicate the results of the project work in a project report

- Must be able to contribute successfully to teamwork within the problem area and make a common presentation of the result of the project work

Type of instruction: Project work with supervision supplemented with instructions, workshops, presentation seminars, lab tests, etc.

Exam format: Individual oral exam based on presentation seminar and project rapport.

Evaluation criteria: Are stated in the Framework Provisions.

Analysis and Solution of an Advanced Civil and/or Structural Engineering Problem
Analyse og løsning af et avanceret problem indenfor byggeri og/eller anlæg

Prerequisites: Corresponding to having passed the 1st and 2nd semester.

Objective: Students who complete the module:

Knowledge:
- Must have knowledge about analytical, numerical and experimental methods for investigation of the chosen problem.

Skills:
- Must be able to apply advanced analytical and/or numerical and/or experimental methods for analysis and assessment of the chosen problem.
- Must be able to compare and evaluate limitations and uncertainties related to the methods used for solving the chosen problem.

Competencies:
- Must be able to apply proper terminology in oral, written and graphical communication and documentation of problems and solutions within the chosen field.
- Must be able to communicate the results of the project work in a project report
- Must be able to contribute successfully to teamwork within the problem area and make a common presentation of the result of the project work

Type of instruction: Project work with supervision supplemented with instructions, workshops, presentation seminars, lab tests, etc.

Exam format: Individual oral exam based on presentation seminar and project rapport.

Evaluation criteria: Are stated in the Framework Provisions.

Coastal, Offshore and Port Engineering
Vandbygning

Prerequisites: Fluid and Water Wave Dynamics

Objective: Students who complete the module:

Knowledge:

- Must have knowledge about non-linear waves, including 2nd and 5th order and stream function theory
- Must have knowledge about methods for extreme climate analysis
- Must have knowledge about currents and water level variations in the coastal zone
- Must have knowledge about environmental loads on coastal, offshore and port structures including ice, wave, current and wind loads.
- Must have knowledge about sediment transport, scour and scour protection
- Must have knowledge about port layout and design of breakwaters

Skills:

- Must be able to calculate design wave height from wave observations
- Must be able to make a conceptual calculation of characteristic wave loads for coastal, offshore and port structures

Competencies:

- Must be able to apply proper terminology in oral, written and graphical communication and documentation within coastal, offshore and port engineering.

Type of instruction: Lectures, etc. supplemented with project work, workshops, presentation seminars, lab tests

Exam format: Individual oral or written exam. Exam format is decided on by start of semester.

Evaluation criteria: Are stated in the Framework Provisions.

Fluid and Water Wave Dynamics
Strømningslære og bølgehydraulik

Prerequisites: A BSc degree in Civil Engineering, Structural Engineering or similar.

Objective: Students who complete the module:

Knowledge:

- Must have knowledge about fluid kinematics
- Must have knowledge about stresses in fluids, equation of motion, constitutive models and Navier-Stokes equations
- Must have knowledge about ideal fluids and potential flows, including application of potential theory to simple problems for example circular cylinder and calculation of hydrodynamic mass.

- Must have knowledge and understanding of Reynolds averaging and turbulence models
- Must be able to describe turbulent and laminar boundary layers including understanding of momentum equation for boundary layers
- Must be able to describe wind generated waves
- Must understand the application of potential theory to linear surface waves on a horizontal bed, including description and linearisation of boundary conditions, solving Laplace equation and the dispersion equation.
- Kinematic and dynamic description of linear surface waves, including particle velocities and accelerations, pressure field, particle paths, wave energy, energy flux and group velocity.
- Description of waves in shallow water, i.e. shoaling, refraction, diffraction and wave breaking
- Statistical description of waves in time and frequency domain

Skills:

- Must be able to describe assumptions and limitations of mathematical models for different types of flows
- Must be able to apply analytical and semi-empirical methods for mathematical description of fluid dynamic problems.
- Must be able to calculate of kinematics and dynamics of regular linear waves on deep and shallow water
- Must be able to analyse irregular waves in time and frequency domain

Competencies:

- Must be able to apply proper terminology in oral, written and graphical communication and documentation within fluid and water wave dynamics.

Type of instruction: Lectures, etc. supplemented with project work, workshops, presentation seminars, lab tests.

Exam format: Individual oral or written exam. Exam format is decided on by start of semester.

Evaluation criteria: Are stated in the Framework Provisions.

Fracture Mechanics and Fatigue
Brudmekanik og udmattelse

Prerequisites: The course modules in: Structural mechanics

Objective: Students who complete the module:

Knowledge:

- Should have basic knowledge about fracture mechanics analysis in order to establish criteria for crack initiation and crack growth.
- Should have knowledge about application of fracture mechanics in engineering applications.
- Should have knowledge about models for analysis of fatigue i.e. models for crack growth and influence of loading sequences.

- Should have knowledge about application of fatigue analysis in engineering applications.

Skills:

- Should understand the stress and strain variations near a crack tip.
- Should understand and be able to perform quantitative and qualitative analysis of stress intensity factors.
- Should understand the crack driving force based on energy analysis.
- Should understand the influence of plasticity in the fracture process.
- Should understand the basic models for crack growth.
- Should understand different scenarios in fatigue analysis e.g. stress or strain driven, low- or high cycle fatigue.
- Should understand and be able to use methods for analysis of stress variations (e.g. Rain-Flow counting).
- Should understand and be able to use Palmgren-Miners damage model.
- Should be able to calculate the lifetime of welded components.
- Use correct professional terminology

Competencies:

- Should be able to participate in analysis of risk of fracture in engineering structures and in a dialog on structural modifications in order to reduce the risk of fracture.
- Should be able to model, calculate and communicate fatigue analysis of welded structures and participate in a dialog of fatigue analysis of other structural components.

Type of instruction: Lectures, etc. supplemented with project work, workshops, presentation seminars, lab tests.

Exam format: Individual oral or written exam. Exam format is decided on by start of semester.

Evaluation criteria: Are stated in the Framework Provisions.

Master's Thesis
Kandidatspeciale

Prerequisites: Successful completion of the first three semesters of the master programme.

Objective:
After completion of the project, the student should within the following topics:

Knowledge:

- Have knowledge and comprehension within the field of the specialization at the highest international level

- Be able to critically evaluate knowledge and identify new scientific problems within the field of the specialization
- Have understanding of implications within the related research area including research ethics

Skills:

- Independently explain choice of scientific theoretical and/or experimental methods
- During the project and when finalising it make an independent and critical estimation of the chosen theories and methods as well as the analyses, results and conclusions
- Be able to apply a wide range of engineering methods in research and development in the field of specialization
- Be able to communicate relevant scientific and professional aspects of project work in a clear and systematic way both to specialists and the public

Competencies:

- Be able to work independently with a project on a specific problem within the field of the specialization at the highest international level
- Independently be able to define and analyse scientific problems and based on that make and state the reasons for the decisions made
- Be competent to solve new and complicated technical problems by the use of advanced mathematics, scientific and technological knowledge
- Be able to evaluate the progress of the project independently and select and include additional literature, experiments or data when needed in order to maintain a scientific basis for the project
- Be able to control complex and unexpected working situations and be able to develop new solutions
- Must be able to communicate the results of the project work in a project report

Type of instruction: Project work with supervision supplemented with instructions, workshops, presentation seminars, lab tests, etc.

Exam format: Individual oral exam based on presentation seminar and project rapport.

Evaluation criteria: Are stated in the Framework Provisions.

Material Modelling in Civil Engineering
Materialemodellering i byggeri og anlæg

Prerequisites: A BSc degree in Civil Engineering, Structural Engineering or similar

Objective: Students who complete the module:

Knowledge:

- Understand fundamental properties of construction materials in civil engineering with emphasis on their mechanical response
- Understand fundamental theories and methods for analysis of structural material behaviour, including elasticity and plasticity

- Have an understanding of the implementation of material models into computational codes including the Finite Element Method
- Have a basic knowledge and understanding of experimental work related to calibration of material models

Skills:

- Use correct terminology regarding the behaviour and modelling of construction materials
- Be able to formulate a constitutive model for the behaviour of a construction material
- Be able to implement a constitutive model for a construction material into a computer code
- Be able to calibrate a constitutive material model based on laboratory tests
- Be able to conduct numerical analysis of civil engineering problems involving nonlinear material behaviour
- Be able to plan and set up tests for determining material properties and calibrating constitutive models

Competencies:

- Be able to analyse the behaviour of construction materials
- Be able to select and apply appropriate material models for the analysis of structural behaviour under different load conditions
- Be able to compare results obtained by different constitutive models and be able to judge the quality of the results

Type of instruction: Lectures, etc. supplemented with project work, workshops, presentation seminars, lab tests.

Exam format: Individual oral or written exam. Exam format is decided on by start of semester.

Evaluation criteria: Are stated in the Framework Provisions.

Renewable Energy Structures: Wind Turbines and Wave Energy Devices
Konstruktioner til vedvarende energi: vindmøller og bølgeenergianlæg

Prerequisites: The course modules: Structural Mechanics and Dynamics; Risk and Reliability in Engineering; Fluid and Water Wave Dynamics; Coastal, offshore and port engineering

Objective: Students who complete the module:

Knowledge:

- Understand basic functioning of wind turbines and wave energy devices
- Know methods for design of main structural components for wind turbines and wave energy devices

Skills:

- Be able to assess wave energy resources and wave loads on wave energy devices

- Be able to assess load effects in structural elements in wave energy devices, and verification for ULS and fatigue limit states
- Be able to assess correlation between wind wave and current, incl. weather windows
- Be able to apply methods for verification of sufficient reliability of wind turbines
- Be able to apply basic aerodynamics, aeroelasticity and rotordynamics for wind turbines
- Be able to assess wind energy resources
- Be able to assess load effects in structural elements in wind turbines, and verification for ULS and fatigue during operation and stand-still
- Use correct professional terminology

Competencies:

- Be able to understand and communicate basic design problems for wind turbines and wave energy devices.

Type of instruction: Lectures, etc. supplemented with project work, workshops, presentation seminars, lab tests.

Exam format: Individual oral or written exam. Exam format is decided on by start of semester.

Evaluation criteria: Are stated in the Framework Provisions.

Risk and Reliability in Engineering
Risiko og sikkerhed af konstruktioner

Prerequisites: Probability theory and statistics

Objective: Students who complete the module:

Knowledge:

- Understand the concepts risk, uncertainty, reliability and safety
- Know statistical methods for modeling physical, model, statistical and measurement uncertainties
- Know methods for assessment of reliability of structural systems using probabilistic methods
- Know methods for systems reliability for non-structural components and its applications in engineering

Skills:

- Be able to model physical, statistical, model and measurement uncertainties
- Be able to use failure rates and hazard functions to model failures in systems reliability for non-structural components
- Be able to model uncertainties for loads and strengths
- Be able to estimate the reliability by FORM/SORM methods (reliability index method) and by simulation
- Be able to model system behavior and estimate the reliability of series and parallel systems

- Understand basic concepts of stochastic processes and time-variant reliability methods
- Be able to estimate characteristic and design values for strength parameters and load bearing capacities, and for environmental loads and load effects using test data and measurements
- Be able to calibrate partial safety factors and load combination factors
- Be able to apply Bayesian statistical methods
- Be able to apply of risk & reliability methods for probabilistic design of engineering structures such as buildings, bridges, offshore structures, costal structures, wind turbines etc.
- Use correct professional terminology

Competencies:

- Be able to participate in a dialog on modeling of uncertainties, risk analysis and assessment of reliability of structural and non-structural components and systems
- Be able to model, calculate and communicate risk analysis, modeling of uncertainties and assessment of reliabilities for engineering problems.

Type of instruction: Lectures, etc. supplemented with project work, workshops, presentation seminars, lab tests.

Exam format: Individual oral or written exam. Exam format is decided on by start of semester.

Evaluation criteria: Are stated in the Framework Provisions.

Structural Mechanics and Dynamics
Strukturel Mekanik og Dynamik

Prerequisites: A BSc degree in Civil Engineering, Structural Engineering or similar.

Objective: Students who complete the module:

Knowledge

- Understand how kinematics of different structural elements are related to general continuum mechanics
- Understand fundamental properties of structural systems with emphasis on their impact on the dynamic response
- Know fundamental theories and methods for analysis of dynamic structural response
- Have an understanding of the solution procedure in Finite Element Analysis of linear elastic dynamic problems
- Have a basic knowledge and understanding of experimental work related to dynamic testing of structures

Skills

- Use correct terminology for structural dynamic analysis
- Based on general continuum mechanics, be able to formulate a model for a given structural problem, and based on the assumed

kinematics, to establish a finite element formulation with the aid of the principle of virtual work.
- Be able to analyse the dynamic response of single-degree-of-freedom systems
- Be able to analyse the dynamic response of multi-degree-of-freedom systems
- Be able to analyse the dynamic response of structures in time domain and frequency domain
- Be able to conduct modal analysis of structures
- Develop and implement a Finite Element software code for dynamic analysis of a multi-degree-of-freedom system
- Be able to use a commercial Finite Element code for analysing the dynamic response of a given structure
- Be able to plan and set up a test for determining dynamic structural response

Competencies
- Be able to analyse the dynamic response of a civil engineering structure
- Be able to select appropriate analysis methods for the analysis of dynamic structural response
- Be able to compare results obtained from different analysis methods and be able to judge the quality of the results
- Be able to quantify errors associated with different types of analysis and evaluate the methods regarding assumptions and simplifications

Type of instruction: Lectures, etc. supplemented with project work, workshops, presentation seminars, lab tests.

Exam format: Individual oral or written exam. Exam format is decided on by start of semester.

Evaluation criteria: Are stated in the Framework Provisions.

The Excitation and Foundation of Marine Structures
Marine konstruktioners belastning og fundering

Prerequisites: Corresponding to having passed the 1st semester.

Objective: Students who complete the module:

Knowledge:
- Must have knowledge about design rules for marine structures including methods for deterministic and probabilistic assessment of loads on marine structures.
- Must have knowledge about analytical, numerical and experimental methods for investigation of marine and geotechnical problems.

Skills:
- Must be able to perform a marine and geotechnical site assessment and a design basis

- Must be able to apply advanced numerical and experimental methods for analysis and assessment of loads and geotechnical response of marine structures
- Must be able to compare and evaluate limitations and uncertainties related to simple and advanced methods for estimation of environmental load as well as geotechnical bearing capacity and deformations.
- Must be able to evaluate the safety by application of probabilistic methods for assessment of loads and bearing capacity of marine structures.

Competencies:

- Must be able to apply proper terminology in oral, written and graphical communication and documentation of problems and solutions within marine structures.
- Must have an overview of design aspects related to marine structures.
- Must be able to communicate the results of the project work in a project report
- Must be able to contribute successfully to teamwork within the problem area and make a common presentation of the result of the project work

Type of instruction: Project work with supervision supplemented with instructions, workshops, presentation seminars, lab tests, etc.

Exam format: Individual oral exam based on presentation seminar and project rapport.

Evaluation criteria: Are stated in the Framework Provisions.

Traineeship at an Engineering Company
Virksomhedsophold

Prerequisites: Corresponding to having passed the 1st and 2nd semester.

Objective: Students who complete the module:

Knowledge:

- Must have knowledge about analytical, numerical and/or experimental methods for investigation of advanced problems within the company's field.

Skills:

- Must be able to apply advanced analytical, numerical and/or experimental methods for analysis and assessment of advanced problems within the company's field.
- Must be able to compare and evaluate limitations and uncertainties related to the methods used for solving advanced problems within the company's field.

Competencies:

- Must be able to apply proper terminology in oral, written and graphical communication and documentation of problems and solutions within the company's field.
- Must be able to communicate the results of the project work in a project report

Type of instruction: Traineeship in a company and project work. The study board must approve on the content of the project work before the Traineeship is commenced.

Exam format: Individual oral exam based on presentation seminar and project rapport.

Evaluation criteria: Are stated in the Framework Provisions.

Wind Loads on Structures
Vindlast på konstruktioner

Prerequisites: The course modules: Structural Mechanics and Dynamics; Risk and Reliability in Engineering

Objective: Students who complete the module:

Knowledge:

- Understand the nature of wind: wind profile, mean wind, extreme wind, turbulence, turbulence field – for applications for structures such as buildings, bridges and wind turbines.
- Understand modeling and calculation of wind loads on civil engineering structures
- Understand stochastic processes, stochastic dynamics and wind actions on structures
- Understand basic stochastic dynamics and its applications in engineering, especially for wind actions

Skills:

- Be able to calculate static and dynamic wind loads on buildings
- Be able to assess cross-wind load actions such as rhythmic vortex shedding and galloping
- Be able to assess structures exposed to wind load in ULS and SLS (comfort)
- Be able to apply rules for wind actions in design codes
- Be able to assess wind loads on bridges
- Use correct professional terminology

Competencies:

- Be able to model, calculate and communicate wind loads on civil engineering structures.

Type of instruction: Lectures, etc. supplemented with project work, workshops, presentation seminars, lab tests.

Exam format: Individual oral or written exam. Exam format is decided on by start of semester.

Evaluation criteria: Are stated in the Framework Provisions.