



AALBORG UNIVERSITET

**STUDIEORDNING FOR  
KANDIDATUDDANNELSEN  
(CAND.POLYT.) I BYGGE- OG  
ANLÆGSKONSTRUKTION, 2017,  
VERSION 2 (AALBORG)**

CIVILINGENIØR  
AALBORG

## **MODULER SOM INDGÅR I STUDIEORDNINGEN**

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# STIFFNESS ANALYSIS OF LOAD-BEARING STRUCTURES

**2020/2021**

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### 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.
- Understand the solution procedure in Finite Element Analysis of linear elastic static problems.
- Understand methodology for design of experiments and test series and for reduction of ambiguity of experimental results, and for comparability with model predictions.
- Understand elementary and advanced quantification tools, and their application to validation between model and experiment data.
- 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 perform a probabilistic study of the experimental data in order to quantify the influence of individual parameters.
- Be able to scrutinize a model (analytical or numerical) for comparison with an appropriate experimental study.
- Be able to perform a probabilistic study of the model in order to quantify the level of confidence.
- Be able to count for the level of coherence between test results and model predictions.
- Be able to identify invalid data (outliers).
- Be able to account for common errors and limitations in the processing of model data of experimentally obtained data.

#### COMPETENCES

- 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 undertake experiment planning and execution for refinement and validation (or rejection) of model-based predictions of phenomena within structural and civil Engineering.
- 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.

## EXTENT AND EXPECTED WORKLOAD

Since it is a 10 ECTS project module, the workload is expected to be 300 hours for the student.

## EXAM

### EXAMS

Name of exam	Stiffness Analysis of Load-Bearing Structures
Type of exam	Oral exam based on a project Oral group exam based on presentation seminar and project report.
ECTS	10
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

## FACTS ABOUT THE MODULE

Danish title	Stivhedsanalyse af bærende konstruktioner
Module code	B-BK-K1A-2
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	10
Language of instruction	Danish and English
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Christian Frier</a>

## ORGANISATION

Study Board	Study Board of the Build Environment
Department	Department of the Built Environment
Faculty	Faculty of Engineering and Science

# **INTRODUCTION TO PROBLEM BASED LEARNING WITHIN STRUCTURAL AND CIVIL ENGINEERING**

**2020/2021**

## **CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE**

### **LEARNING OBJECTIVES**

#### **KNOWLEDGE**

Students who complete the module:

- Must have knowledge about Problem Based Learning (PBL).
- Must have knowledge about the Aalborg model approach to PBL.
- Must have knowledge about various techniques for planning and management of the group-based project work.
- Must have a basic fundamental knowledge about analytical, numerical and experimental work for estimating the response of a simple structural part (deformations and/or stresses and strains).
- Have a basic knowledge about uncertainties and limitations of different types of modelling and testing when analyzing a simple structural part.

#### **SKILLS**

Students who complete the module:

- Must be able to plan and manage a problem-based and project-organized study project carried out by a project group.
- Must be able to communicate project results and processes in a coherent, structured and understandable manner, both in writing, verbally and graphically.
- Must be able to analyze and evaluate own study efforts and learning in relation to a problem-based group work with a view to continued professional development.
- Must be able to analyze and evaluate collective learning processes for joint knowledge development and exchange of experience.
- Be able to perform analytical, numerical and experimental analysis in order to obtain the response of a simple structural part.
- Be able to compare results and reflect upon assumptions and uncertainties.

#### **COMPETENCES**

Students who complete the module:

- Must be able to engage in, reflect on and optimize own participation in a group-based project.
- Must be able to consciously reflect on and develop own learning.
- Must be able to engage in, reflect on and optimize collective learning processes in relation to analyzing a simple structural part.

#### **TYPE OF INSTRUCTION**

Project work with supervision supplemented with instructions lab tests, etc.

#### **EXTENT AND EXPECTED WORKLOAD**

Since it is a 5 ECTS project module, the workload is expected to be 150 hours for the student.

## EXAM

### EXAMS

Name of exam	Introduction to Problem Based Learning within Structural and Civil Engineering
Type of exam	Oral exam based on a project Oral exam based on presentation seminar and project report.
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

### FACTS ABOUT THE MODULE

Danish title	Introduktion til problembaseret læring inden for bygge- og anlægskonstruktion
Module code	B-BK-K1A-1
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Christian Frier</a>

### ORGANISATION

Study Board	Study Board of the Build Environment
Department	Department of the Built Environment
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# STRUCTURAL MECHANICS AND DYNAMICS

2020/2021

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### 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.

#### COMPETENCES

- 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.

#### EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS project module, the workload is expected to be 150 hours for the student.

## EXAM

### EXAMS

Name of exam	Structural Mechanics and Dynamics
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination



Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures
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## FACTS ABOUT THE MODULE

Danish title	Strukturel Mekanik og Dynamik
Module code	B-BK-K1A-3
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Christian Frier</a>

## ORGANISATION

Study Board	Study Board of the Built Environment
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# MATERIAL MODELLING IN CIVIL ENGINEERING

## 2020/2021

### CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

#### LEARNING OBJECTIVES

##### KNOWLEDGE

- Understand fundamental properties of structures and 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.
- Understand fundamental continuum mechanics theories for solids, plates and beams.
- 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 set up the static, kinematic and constitutive relations for solving a mechanical problem.
- Be able to apply the principle of virtual work in solving mechanical problems.
- Be able to apply classical elastic and plastic material models for simulating structural material behaviour.

##### COMPETENCES

- Be able to analyse the behaviour of structures and 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.
- Be able to compare results obtained by different structural 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.

##### EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS project module, the workload is expected to be 150 hours for the student.

## EXAM

### EXAMS

Name of exam	Material Modelling in Civil Engineering
Type of exam	Written or oral exam Individual oral or written exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

## FACTS ABOUT THE MODULE

Danish title	Materialemodellering i byggeri og anlæg
Module code	B-BK-K1A-4
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Christian Frier</a>

## ORGANISATION

Study Board	Study Board of the Build Environment
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Faculty	Faculty of Engineering and Science

# FLUID AND WATER WAVE DYNAMICS

**2020/2021**

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

Students who complete the module:

- 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

Students who complete the module:

- 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.

#### COMPETENCES

Students who complete the module:

- 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.

#### EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS project module, the workload is expected to be 150 hours for the student.

## EXAM

### EXAMS

Name of exam	Fluid and Water Wave Dynamics
Type of exam	Written or oral exam Individual oral or written exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

### FACTS ABOUT THE MODULE

Danish title	Strømningslære og bølgehydraulik
Module code	B-BK-K1A-5
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Christian Frier</a>

### ORGANISATION

Study Board	Study Board of the Build Environment
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# THE EXCITATION AND FOUNDATION OF MARINE STRUCTURES

**2020/2021**

## PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge gained on 1st semester.

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### 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.

#### COMPETENCES

- 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.

#### EXTENT AND EXPECTED WORKLOAD

Since it is a 15 ECTS project module, the workload is expected to be 450 hours for the student.

## EXAM

### EXAMS

Name of exam	The Excitation and Foundation of Marine Structures
Type of exam	Oral exam based on a project Oral group exam based on presentation seminar and project rapport.

ECTS	15
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

## FACTS ABOUT THE MODULE

Danish title	Marine konstruktioners belastning og fundering
Module code	B-BK-K2A-6
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	15
Language of instruction	Danish and English
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Thomas Lykke Andersen</a>
Time allocation for external examiners	B

## ORGANISATION

Study Board	Study Board of the Build Environment
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# COASTAL, OFFSHORE AND PORT ENGINEERING

## 2020/2021

### PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge gained in Fluid and Water Wave Dynamics

### CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

#### LEARNING OBJECTIVES

##### KNOWLEDGE

Students who complete the module:

- Must have knowledge about non-linear waves, including 2<sup>nd</sup> and 5<sup>th</sup> 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

Students who complete the module:

- 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.

##### COMPETENCES

Students who complete the module:

- 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

##### EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS project module, the workload is expected to be 150 hours for the student.

### EXAM

#### EXAMS

Name of exam	Coastal, Offshore and Port Engineering
Type of exam	Written or oral exam Individual oral or written exam
ECTS	5



Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

## FACTS ABOUT THE MODULE

Danish title	Vandbygning
Module code	B-BK-K2A-7
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Thomas Lykke Andersen</a>

## ORGANISATION

Study Board	Study Board of the Build Environment
Department	Department of the Built Environment
Faculty	Faculty of Engineering and Science

# RISK AND RELIABILITY IN ENGINEERING

**2020/2021**

## PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge gained in Probability Theory and Statistics

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### 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 risk and reliability methods for probabilistic design of engineering structures such as buildings, bridges, offshore structures, coastal structures, wind turbines etc.
- Use correct professional terminology.

#### COMPETENCES

- Be able to participate in a dialog on modelling 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, modelling of uncertainties and assessment of reliabilities for engineering problems.

#### TYPE OF INSTRUCTION

Lectures, etc. supplemented with project work, workshops, presentation seminars, lab tests.

#### EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS project module, the workload is expected to be 150 hours for the student.

## EXAM

### EXAMS

Name of exam	Risk and Reliability in Engineering
Type of exam	Written or oral exam Individual oral or written exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

### FACTS ABOUT THE MODULE

Danish title	Risiko og sikkerhed af konstruktioner
Module code	B-BK-K2A-9
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">John Dalsgaard Sørensen</a>

### ORGANISATION

Study Board	Study Board of the Build Environment
Department	Department of the Built Environment
Faculty	Faculty of Engineering and Science

# ANALYSIS AND SOLUTION OF AN ADVANCED CIVIL AND/OR STRUCTURAL ENGINEERING PROBLEM

**2020/2021**

## PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge gained on 1st and 2nd semester.

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

Students who complete the module:

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

#### SKILLS

Students who complete the module:

- 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.

#### COMPETENCES

Students who complete the module:

- 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.

#### EXTENT AND EXPECTED WORKLOAD

Since it is a 15 ECTS project module, the workload is expected to be 450 hours for the student.

## EXAM

### EXAMS

Name of exam	Analysis and Solution of an Advanced Civil and/or Structural Engineering Problem
Type of exam	Oral exam based on a project Oral group exam based on presentation seminar and project rapport.

ECTS	15
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

## FACTS ABOUT THE MODULE

Danish title	Analyse og løsning af et avanceret problem indenfor byggeri og/eller anlæg
Module code	B-BK-K3A-11
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Jannie Sønderkær Nielsen</a>

## ORGANISATION

Study Board	Study Board of the Build Environment
Department	Department of the Built Environment
Faculty	Faculty of Engineering and Science

# ACADEMIC INTERNSHIP

## 2020/2021

### PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge gained on the 1st and 2nd semester modules or similar.

### CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Objective:

Students who complete the module:

#### LEARNING OBJECTIVES

##### 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.

##### COMPETENCES

- 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

Internship in a company and project work. The study board must approve on the content of the project work before the internship is commenced.

#### EXTENT AND EXPECTED WORKLOAD

Since it is a 30 ECTS project module, the workload is expected to be 900 hours for the student.

## EXAM

### EXAMS

Name of exam	Academic Internship
Type of exam	Oral exam based on a project Individual oral exam based on presentation seminar and project rapport.
ECTS	30
Assessment	7-point grading scale
Type of grading	Internal examination

Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures
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## FACTS ABOUT THE MODULE

Danish title	Projektorienteret forløb i en virksomhed
Module code	B-BK-K3A-16
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	30
Language of instruction	Danish and English
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Johan Clausen</a>

## ORGANISATION

Study Board	Study Board of the Build Environment
Department	Department of the Built Environment
Faculty	Faculty of Engineering and Science

# MASTER'S THESIS

**2020/2021**

## PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module adds to the knowledge obtained on the 1st to 3rd Semester

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### 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.

#### COMPETENCES

- 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.

#### EXTENT AND EXPECTED WORKLOAD

Since it is a 30 ECTS project module, the workload is expected to be 900 hours for the student.

## EXAM

### EXAMS

Name of exam	Master's Thesis
Type of exam	Master's thesis/final project Individual oral exam based on presentation seminar and project rapport.



Studieordning for Kandidatuddannelsen (cand.polyt.) i bygge- og anlægskonstruktion, 2017, version 2 (Aalborg)

ECTS	30
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

## FACTS ABOUT THE MODULE

Danish title	Kandidatspeciale
Module code	B-BK-K4A-19
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	30
Language of instruction	Danish and English
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Johan Clausen</a>
Time allocation for external examiners	D

## ORGANISATION

Study Board	Study Board of the Build Environment
Department	Department of the Built Environment
Faculty	Faculty of Engineering and Science

# MASTER'S THESIS

## 2020/2021

### PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module adds to the knowledge obtained on the 1st to 3rd Semester

### CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

#### LEARNING OBJECTIVES

##### 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.

##### COMPETENCES

- 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.

##### EXTENT AND EXPECTED WORKLOAD

Since it is a 45 ECTS project module, the workload is expected to be 1350 hours for the student.

The master thesis is conducted as a long master thesis. A long master thesis has to include experimental work and has to be approved by the study board. The amount of experimental work must reflect the allotted ECTS

### EXAM

#### EXAMS

Name of exam	Master's Thesis
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Studieordning for Kandidatuddannelsen (cand.polyt.) i bygge- og anlægskonstruktion, 2017, version 2 (Aalborg)

Type of exam	Master's thesis/final project Individual oral exam based on presentation seminar and project rapport.
ECTS	45
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

## FACTS ABOUT THE MODULE

Danish title	Kandidatspeciale
Module code	B-BK-K3A-18
Module type	Project
Duration	2 semesters
Semester	Autumn
ECTS	45
Language of instruction	Danish and English
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Johan Clausen</a>
Time allocation for external examiners	D

## ORGANISATION

Study Board	Study Board of the Build Environment
Department	Department of the Built Environment
Faculty	Faculty of Engineering and Science

# ADVANCED SOIL MECHANICS AND STRUCTURES

2020/2021

## PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge gained in Material Modelling in Civil Engineering.

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

- Must know how to interpret and determinate geotechnical design parameters based on cone penetration tests, and advanced laboratory tests (oedometer and triaxial tests).
- Must have knowledge about upper and lower bound method.
- Must have knowledge about deformations calculation of geotechnical structures.
- Must have knowledge about design of vertically and horizontally loaded piles and pile groups.
- Must have knowledge about constitutive models for soil and calibration of these models from relevant laboratory tests.
- Must have knowledge about numerical methods (FEM-based).
- Must know how to analyse geotechnical structures using FEM based methods, e.g deep excavations or temporary geotechnical constructions.

#### SKILLS

- Must be able to design and interpret advanced in-situ and laboratory test programs.
- Must be able to explain and use advanced constitutive models used to model soil response.
- Must be able to design vertical and horizontal loaded piles and pile groups.
- Must be able to analyse geotechnical structures using FEM based methods, e.g. deep excavations or temporary geotechnical structures.

#### COMPETENCES

- Be able to participate in dialog on modelling of advanced soil mechanics
- Be able to model, calculate, communicate and performe advanced numerical analysis of geotechnical structures.
- Application of proper terminology in oral, written and graphical communication and documentation within Soil Mechanics.

#### TYPE OF INSTRUCTION

Lectures, etc. supplemented with project work, workshops, presentation seminars, lab tests.

#### EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS project module, the workload is expected to be 150 hours for the student.

## EXAM

### EXAMS

Name of exam	Advanced Soil Mechanics and Structures
Type of exam	Written or oral exam Individual oral or written exam

Studieordning for Kandidatuddannelsen (cand.polyt.) i bygge- og anlægskonstruktion, 2017, version 2 (Aalborg)

ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

## FACTS ABOUT THE MODULE

Danish title	Videregående geoteknik
Module code	B-BK-K2A-8
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Thomas Lykke Andersen</a>

## ORGANISATION

Study Board	Study Board of the Build Environment
Department	Department of the Built Environment
Faculty	Faculty of Engineering and Science

# ADVANCED STRUCTURAL ENGINEERING

**2020/2021**

## PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge gained on 1st semester

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

Students who complete the module:

- 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 modelling joints in structures linear as well as non-linear.
- Should have knowledge about non-linear Finite Element analysis of thin-walled structures.

#### SKILLS

Students who complete the module:

- Should be able to formulate a mechanical/mathematical 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.

#### COMPETENCES

Students who complete the module:

- 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.

#### EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS project module, the workload is expected to be 150 hours for the student.

## EXAM

### EXAMS

Name of exam	Advanced Structural Engineering
Type of exam	Written or oral exam Individual oral or written exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

### FACTS ABOUT THE MODULE

Danish title	Avancerede konstruktionsanalyser
Module code	B-BK-K2A-10
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Thomas Lykke Andersen</a>

### ORGANISATION

Study Board	Study Board of the Build Environment
Department	Department of the Built Environment
Faculty	Faculty of Engineering and Science

# RENEWABLE ENERGY STRUCTURES: WIND TURBINES AND WAVE ENERGY DEVICES

**2020/2021**

## PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge gained in the course modules: Structural Mechanics and Dynamics, Risk and Reliability in Engineering, Fluid and Water Wave Dynamics, Coastal, Offshore and Port Engineering

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### 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.

#### COMPETENCES

- 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.

### EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS project module, the workload is expected to be 150 hours for the student.

## EXAM

### EXAMS

Name of exam	Renewable Energy Structures: Wind Turbines and Wave Energy Devices
Type of exam	Written or oral exam Individual oral or written exam
ECTS	5



Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

## FACTS ABOUT THE MODULE

Danish title	Konstruktioner til vedvarende energi: vindmøller og bølgeenergianlæg
Module code	B-BK-K3A-12
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Jannie Sønderkær Nielsen</a> , <a href="#">Morten Bech Kramer</a>

## ORGANISATION

Study Board	Study Board of the Built Environment
Department	Department of the Built Environment
Faculty	Faculty of Engineering and Science

# WIND LOADS ON STRUCTURES

2020/2021

## PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge gained in the course modules: Structural Mechanics and Dynamics, Risk and Reliability in Engineering

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### 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 modelling 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 apply methods for stochastic dynamics for application in engineering, especially for wind actions.
- 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.

#### COMPETENCES

- 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.

#### EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS project module, the workload is expected to be 150 hours for the student.

## EXAM

### EXAMS

Name of exam	Wind Loads on Structures
Type of exam	Written or oral exam Individual oral or written exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination

Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures
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## FACTS ABOUT THE MODULE

Danish title	Vindlast på konstruktioner
Module code	B-BK-K3A-13
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">John Dalsgaard Sørensen</a>

## ORGANISATION

Study Board	Study Board of the Build Environment
Department	Department of the Built Environment
Faculty	Faculty of Engineering and Science

# NONLINEAR AND DYNAMIC ANALYSIS OF CIVIL ENGINEERING STRUCTURES

**2020/2021**

## PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge gained in the course modules: Structural Mechanics and Dynamics and Material Modelling in Civil Engineering

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

- Have a general overview of nonlinear effects and mechanisms in civil and structural engineering.
- Understand numerical solution schemes for nonlinear analysis.
- Understand nonlinear constitutive behaviour of granular materials, including concrete.
- Understand numerical treatment of elastoplasticity, including hardening, nonassociated plasticity and strain localization.
- Understand wave propagation in solids, structures and fluids and related mechanisms, including dissipation and dispersion.
- Understand numerical solution schemes for wave propagation.

#### SKILLS

- Be able to apply the finite-element method for analysis of nonlinear problems involving granular materials.
- Be able to apply the finite-element method for analysis of wave propagation in solids, structures and fluids.
- Be able to analyse nonlinear and dynamic response of reinforced concrete structures with the finite-element method.
- Use correct professional terminology.

#### COMPETENCES

- Be able to choose and develop strategies for numerical analysis of problems involving nonlinear material behaviour and/or wave propagation, including judgement of parameters and shortcomings of the models.
- Be able to identify and apply proper numerical solution techniques and material models for assessment of reinforced concrete structures in the serviceability and ultimate limit states.

#### TYPE OF INSTRUCTION

Lectures, etc. supplemented with project work, workshops.

#### EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS project module, the workload is expected to be 150 hours for the student.

## EXAM

### EXAMS

Name of exam	Nonlinear and Dynamic Analysis of Civil Engineering Structures
Type of exam	Oral exam

	Oral exam based on portfolio work in groups.
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

## FACTS ABOUT THE MODULE

Danish title	Ikkelineær og dynamisk analyse af bygge- og anlægskonstruktioner
Module code	B-BK-K3A-14
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Lars Bo Ibsen</a>

## ORGANISATION

Study Board	Study Board of the Build Environment
Department	Department of the Built Environment
Faculty	Faculty of Engineering and Science

# FRACTURE MECHANICS AND FATIGUE

**2020/2021**

## PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge gained in the course module in Structural Mechanics and Dynamics

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Objective:

Students who complete the module:

### LEARNING OBJECTIVES

#### KNOWLEDGE

- Have gained a comprehensive understanding of fracture mechanics.
- Have gained knowledge in applying classical methods in designing against fatigue fracture by studying notches and their effect, by studying strainfatigue, and by analysing eigen-stress states.
- Have gained an understanding of how to apply fracture mechanics in the assessment of reliability of practical designs and machine elements.

#### SKILLS

- Be able to assess the stability of cracks using Griffith's and Irwin's fracture criteria, energy release rate, and toughness concepts.
- Be able to apply linear elastic solutions for sharp cracks and obtain the stress intensity factor.
- Be able to assess mixed mode loading and apply crack growth direction hypotheses.
- Be able to assess crack growth by fatigue, partial damage and load spectra.
- Be able to assess crack initiation, notches and their effect.
- Be able to determine life time and apply methods for improving the fatigue strength and life time of machine elements and welded details.

#### COMPETENCES

- Be able to understand and apply linear elastic concepts in assessing the stability of cracked structures under static and fatigue loading.
- Be able to distinguish between different fatigue regimes, i.e. elastic or plastic, and un-cracked or pre-cracked, and apply correct methodology to each case in relevant structures.
- Be able to determine the lifetime of welded components, and explain fatigue in welded components on the basis of fracture mechanical concepts.

#### TYPE OF INSTRUCTION

Lectures, etc. supplemented with project work, workshops, presentation seminars, lab tests.

#### EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS project module, the workload is expected to be 150 hours for the student.

## EXAM

### EXAMS

Name of exam	Fracture Mechanics and Fatigue
Type of exam	Written or oral exam Individual oral or written exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

### FACTS ABOUT THE MODULE

Danish title	Brudmekanik og udmattelse
Module code	B-BK-K3A-15
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Johan Clausen</a>

### ORGANISATION

Study Board	Study Board of the Build Environment
Department	Department of the Built Environment
Faculty	Faculty of Engineering and Science