



AALBORG UNIVERSITET

**STUDIEORDNING FOR  
KANDIDATUDDANNELSEN  
(CAND.POLYT) I INDEKLIMA OG ENERGI,  
2022**

CIVILINGENIØR  
AALBORG

MODULER SOM INDGÅR I STUDIEORDNINGEN

## INDHOLDSFORTEGNELSE

Ventilation, Airflow and Contaminant Transport in Buildings 2022/2023 .....	3
Numeriske metoder 2022/2023 .....	5
Fluid Mechanics and Computational Fluid Dynamics 2022/2023 .....	7
Building Related Fluid Mechanics 2022/2023 .....	9
Integrated Design of Sustainable Buildings and Building Services 2022/2023 .....	11
Modelling and Design Optimisation by Sensitivity Analysis and Uncertainty Analysis 2022/2023 .....	13
Environmental Assessment Methods and Life Cycle Cost Analysis 2022/2023 .....	15
IT System Development 2022/2023 .....	17
Fault Detection and Diagnosis in Buildings 2022/2023 .....	19
Project-oriented Study in an External Organisation 2022/2023 .....	21
Master's Thesis 2022/2023 .....	23
Master's Thesis 2022/2023 .....	25
Advanced Modelling of Energy Transport in Buildings and HVAC Systems 2022/2023 .....	27
Building Commissioning and Operation 2022/2023 .....	29

# VENTILATION, AIRFLOW AND CONTAMINANT TRANSPORT IN BUILDINGS

**2022/2023**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge gained in the modules Numerical Methods, Fluid Mechanics and Computational Fluid Dynamics, Building Related Fluid Mechanics or similar.

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

Students who complete the module:

- Must understand the theoretical and experimental assessment of heat, mass, and momentum transfer in ventilated enclosures.
- Must understand the relationship between the thermal comfort, indoor air quality and health issues and the heat, mass and momentum transfer in the micro-environment of a human being

#### SKILLS

Students who complete the module:

- Must be able to develop and perform model and/or full-scale experiments related to fluid flow and contaminant transport in ventilated enclosures
- Must be able to measure, evaluate and further develop various flow elements for typical room air distribution systems.
- Must be able to perform CFD simulations in ventilation settings including the establishment of proper boundary conditions.
- Must have the ability to design and evaluate different types of air distribution systems in a room and in a building.

#### COMPETENCES

Students who complete the module:

- Must be able to identify and discuss the optimal solution for an air distribution system based on theory and/or experiments
- Must be able to perform and reflect on experiments related to personal exposure assessment and contaminant transport
- 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

#### LEARNING OBJECTIVES FOR PROBLEM BASED LEARNING

- Must be able to apply problem solving
- Must be able to use problem identification
- Must be able to apply objectives (cooperation agreement)
- Must be able to use contextual involvement (user involvement)
- Must be able to analyse teamwork/team composition
- Must have knowledge of process analysis
- Must be able to use problem formulation
- Must be able to assess meetings/scheduling of meetings
- Must be able to analyse time planning
- Must be able to apply problem analysis
- Must be able to analyse personal competencies and wishes

- Must be able to assess problem solving
- Must be able to apply project management
- Must be able to apply impact assessment

## 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	Ventilation, Airflow and Contaminant Transport in Buildings
Type of exam	Oral exam based on a project Oral 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	Ventilation, luftstrømninger og forureningstransport i bygninger
Module code	B-IE-K1-5
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="#">Chen Zhang</a> , <a href="#">Rasmus Lund Jensen</a>
Time allocation for external examiners	B

## ORGANISATION

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

# NUMERISKE METODER

**2022/2023**

## ANBEFALEDE FAGLIGE FORUDSÆTNINGER FOR AT DELTAGE I MODULET

Modulet bygger videre på viden opnået i "Anvendt ingeniørmatematik" eller lignende.

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

### LÆRINGSMÅL

#### VIDEN

- Have viden og forståelse for grundlæggende numeriske metoder indenfor maskinteknik, energiteknik og byggeteknik.
- Have viden og forståelse for numeriske metoder til løsning af systemer af lineære og ikke-lineære ligninger.
- Have viden om matrix egenværdiproblemer.
- Have viden og forståelse for interpolationsmetoder.
- Have viden og forståelse for numeriske integrationsmetoder.
- Have viden og forståelse for numeriske metoder til første og anden ordens ordinære differentiaalligninger.
- Have viden og forståelse for elliptiske, paraboliske og hyperbolske partielle differentiaalligninger samt brugen af disse indenfor ingeniørområdet.
- Have viden og forståelse for numerisk løsning af partielle differentiaalligninger ved brug af differensmetoder, finite volume metoder og finite element metoder, samt have viden om brugen af disse metoder til ingeniørmæssige problemer.

#### FÆRDIGHEDER

- Skal kunne anvende numeriske metoder til at løse lineære ligningssystemer ved brug af direkte og iterative løsningsmetoder.
- Skal kunne løse en ikke-lineær ligning og systemer af ikke-lineære ligninger ved brug af numeriske metoder.
- Skal kunne estimere og beregne egenværdier og egenvektorer af en matrix.
- Skal kunne anvende forskellige metoder til interpolation af data.
- Skal kunne anvende forskellige metoder til numerisk løsning af bestemte integraler.
- Skal kunne løse første og anden ordens ordinære differentiaalligninger ved brug af numeriske metoder.
- Skal kunne anvende analytiske metoder til at løse partielle differentiaalligninger.
- Skal kunne anvende differensmetoder til at løse elliptiske, paraboliske og hyperbolske partielle differentiaalligninger.
- Skal kunne anvende finite volume metoden til at løse diffusionsligninger.
- Skal kunne anvende finite element metoden til at løse diffusionsligninger.
- Skal kunne anvende computerprogrammet MATLAB til de numeriske metoder dækket i kurset.

#### KOMPETENCER

- Skal kunne håndtere udviklingsorienterede situationer i forbindelse med numeriske metoder i studie- eller arbejdssammenhænge.
- Skal selvstændigt kunne indgå i fagligt og tværfagligt samarbejde med en professionel tilgang inden for matematiske numeriske metoder.
- Skal kunne identificere egne læringsbehov og strukturere egen læring inden for numeriske metoder.

#### UNDERVISNINGSFORM

Undervisningen tilrettelægges i henhold til de generelle undervisningsformer for uddannelsen, jf. studieordningens §17.

#### OMFANG OG FORVENTET ARBEJDSINDSAT

Da det er et 5 ECTS kursus forventes der en arbejdsbyrde på 150 timer.

## EKSAMEN

### PRØVER

Prøvens navn	Numeriske metoder
Prøveform	Skriftlig eller mundtlig
ECTS	5
Bedømmelsesform	7-trins-skala
Censur	Intern prøve
Vurderingskriterier	Vurderingskriterierne er angivet i Universitetets eksamensordning

### FAKTA OM MODULET

Engelsk titel	Numerical Methods
Modulkode	M-MP-B5-3B
Modultype	Kursus
Varighed	1 semester
Semester	Efterår og Forår
ECTS	5
Undervisningssprog	Engelsk
Tomplads	Ja
Undervisningssted	Campus Aalborg, Campus Esbjerg
Modulansvarlig	<a href="#">Erik Lund</a> , <a href="#">Thomas Condra</a> , <a href="#">Ahmad Arabkoohsar</a>

### ORGANISATION

Studienævn	Studienævn for Mekanik og Fysik
Institut	Institut for Materialer og Produktion
Fakultet	Det Ingeniør- og Naturvidenskabelige Fakultet

# FLUID MECHANICS AND COMPUTATIONAL FLUID DYNAMICS

**2022/2023**

## 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.
- 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 have knowledge about numerical methods in fluid mechanics.
- Must have knowledge about the finite volume method of computational fluid dynamics.
- Must have knowledge about mesh types and boundary conditions.

#### 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 appropriate analytical, semi-empirical and numerical methods for mathematical description of fluid dynamic problems.
- Must be able to evaluate results from such methods

#### COMPETENCES

Students who complete the module:

- Must be able to apply proper terminology in oral, written and graphical communication and documentation within fluid dynamics.
- Must be able to apply the topic of the module in multi-disciplinary contexts.

#### TYPE OF INSTRUCTION

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

#### EXTENT AND EXPECTED WORKLOAD

The module is 5 ECTS which is corresponding to 150 hours of study.

## EXAM

### EXAMS

Name of exam	Fluid Mechanics and Computational Fluid Dynamics
--------------	--

Type of exam	Written or oral exam The exam is carried out either separately or in connection with the project exam. Form of examination is determined at the beginning of the semester.
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 CFD
Module code	B-IE-K1-8
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="#">Chen Zhang</a> , <a href="#">Rasmus Lund Jensen</a>

## ORGANISATION

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



# BUILDING RELATED FLUID MECHANICS

**2022/2023**

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

Students who complete the module:

- Must obtain a detailed knowledge of building related heat, mass, and momentum transport
- Must obtain knowledge of building related application of similarity principles and turbulence modelling
- Must understand different simplified procedures, as the generation of flow elements
- Must understand the principles of heat and mass transfer in the micro-environment of a human being

#### SKILLS

Students who complete the module:

- Must be able to develop the basis for model and/or full-scale experiments
- Must be able to develop flow elements for room air distribution
- Must be able to setup and perform advanced CFD simulations of naturally and mechanically ventilated buildings including occupant modelling
- Must be able to develop proper boundary conditions for CFD in ventilation
- Must have the ability to choose, design and evaluate the different types of air distribution in a room and in a building
- Must have the ability to apply relevant models in building related fluid mechanics
- Must be able to simulate and analyze the natural airflow of a single zone and a multizone building

#### COMPETENCES

Students who complete the module:

- Must be able to establish, evaluate and reflect on models on room air distribution and personal exposure assessment in building related fluid mechanics
- Must be able to combine and reflect on the various methods applied in the area of building related fluid mechanics and establish relevant solutions

#### TYPE OF INSTRUCTION

Project work with supervision, etc. supplemented with instructions, workshops, presentation seminars, lab tests.

#### EXTENT AND EXPECTED WORKLOAD

The module is 5 ECTS which is corresponding to 150 hours of study.

## EXAM

### EXAMS

Name of exam	Building Related Fluid Mechanics
Type of exam	Written or oral exam The exam is carried out either separately or in connection with the project exam. Form of examination is determined at the beginning of the semester.

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	Bygningsrelateret strømningsmekanik
Module code	B-IE-K1-6A
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="#">Chen Zhang</a> , <a href="#">Rasmus Lund Jensen</a>

## ORGANISATION

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

# INTEGRATED DESIGN OF SUSTAINABLE BUILDINGS AND BUILDING SERVICES

**2022/2023**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge corresponding to 1st semester and knowledge gained in the modules Stochastic Modelling and Design Optimisation, Integrated Building Energy Design and Environmental Assessment Methods and Life Cycle Cost Analysis or similar.

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

Students who complete the module:

- Must have knowledge about sustainable building design
- Must have knowledge about basic architectural design methodology, the integrated design process and integrated building concepts
- Must have knowledge on choice of passive energy technologies in relation to indoor environment and building services
- Must be able to understand the interplay between microclimate, buildings and their services
- Must be able to understand the interplay between sustainable energy system, building energy demand and renewable energy production
- Must have knowledge of stochastic performance modeling of buildings

#### SKILLS

Students who complete the module:

- Must be able to apply and combine design methods for passive energy technologies
- Must be able to apply and combine design methods for energy efficient building design
- Must be able to apply, combine and evaluate advanced methods for analysis of the interplay between energy systems, architectural concepts, building design, building use, outdoor climate and HVAC systems
- Must be able to apply, combine and evaluate advanced methods for analysis and design of sustainable buildings
- Must be able to evaluate building energy performance and assess their robustness through sensitivity and uncertainty analyses

#### 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 integrated design of sustainable buildings and building services.
- Must be able to handle complex and research-oriented cases related to development of sustainable buildings
- Must be able to take part in a professional and interdisciplinary collaboration on design of integrated building and energy concepts
- 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

#### LEARNING OBJECTIVES FOR PROBLEM BASED LEARNING

- Must be able to assess problemsolving
- Must be able to assess teamwork/team composition
- Must be able to understand and explain what process analysis is
- Must be able to assess impact assessment

## 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

### PREREQUISITE FOR ENROLLMENT FOR THE EXAM

- An approved PBL competency profile is a prerequisite for participation in the project exam.

## EXAMS

Name of exam	Integrated Design of Sustainable Buildings and Building Services
Type of exam	Oral exam based on a project Oral exam based on presentation seminar and project rapport.
ECTS	20
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	Integreret design af bæredygtige bygninger og bygningsinstallationer
Module code	B-IE-K2-9A
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	20
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Tine Steen Larsen</a>

## ORGANISATION

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

# MODELLING AND DESIGN OPTIMISATION BY SENSITIVITY ANALYSIS AND UNCERTAINTY ANALYSIS

## 2022/2023

### CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

#### LEARNING OBJECTIVES

##### KNOWLEDGE

Students who complete the module:

- Must be able to understand the background and theory of sensitivity analysis and uncertainty analysis in indoor environmental and energy engineering
- Must be able to explain how sensitivity analysis and uncertainty analysis are used in design optimization
- Must have knowledge of Machine Learning and Artificial Intelligence

##### SKILLS

Students who complete the module:

- Must be able to investigate, explain and develop indoor environmental and energy engineering models using sensitivity analysis and uncertainty analysis
- Must be able to quantify the influence of uncertainty in indoor environmental and energy engineering using Monte Carlo modeling
- Must be able to apply sensitivity analysis and uncertainty analysis in design optimization

##### COMPETENCES

Students who complete the module:

- Must be able to choose proper modelling of single zone and multizone buildings and discuss inherent model limitations
- Must be able to discuss and reflect on the accuracy of indoor environmental and energy engineering models subject to uncertainty

##### TYPE OF INSTRUCTION

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

##### EXTENT AND EXPECTED WORKLOAD

The module is 5 ECTS which is corresponding to 150 hours of study.

### EXAM

#### EXAMS

Name of exam	Modelling and Design Optimisation by Sensitivity Analysis and Uncertainty Analysis
Type of exam	Written or oral exam The exam is carried out either separately or in connection with the project exam. Form of examination is determined at the beginning of the semester.
ECTS	5

Assessment	Passed/Not Passed
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	Modellering og design optimering ved sensitivitets- og usikkerhedsanalyse
Module code	B-IE-K2-10A
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Tine Steen Larsen</a>

## ORGANISATION

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

# ENVIRONMENTAL ASSESSMENT METHODS AND LIFE CYCLE COST ANALYSIS

**2022/2023**

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

Students who complete the module:

- Must have knowledge about the design philosophy and calculation methods for minimizing the environmental impact of a building throughout its life cycle
- Must have knowledge about the energy and environmental assessment of buildings including material production and transportation, building construction, operation, refurbishment, recycling, demolition and removal
- Must have knowledge about sustainable technologies and environmental design concepts
- Must have knowledge about assessment and certification methods for high performance buildings
- Must have knowledge about LCC analysis
- Must have knowledge about Cost Optimization

#### SKILLS

Students who complete the module:

- Must be able to perform a Life Cycle Assessment a building
- Must be able to evaluate buildings by using assessment and certification methods for high performance buildings
- Must be able to perform a LCC analysis
- Must be able to automate basic cost optimization

#### COMPETENCES

Students who complete the module:

- Must be able to discuss and reflect on the prospects and limitations of Environmental Assessment Methods and Tools
- Can evaluate methodologies of building certification methods
- Must be able to evaluate and choose between different building designs based on LCC Analysis and Cost Optimization
- Must be able to discuss and reflect on the prospects and limitations of LCC Analysis and Cost Optimization

#### TYPE OF INSTRUCTION

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

#### EXTENT AND EXPECTED WORKLOAD

The module is 5 ECTS which is corresponding to 150 hours of study.

## EXAM

### EXAMS

Name of exam	Environmental Assessment Methods and Life Cycle Cost Analysis
--------------	---

Type of exam	Written or oral exam The exam is carried out either separately or in connection with the project exam. Form of examination is determined at the beginning of the semester.
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	Bæredygtige vurderingsmetoder og LCC analyse
Module code	B-IE-K2-12
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Tine Steen Larsen</a>

## ORGANISATION

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



# IT SYSTEM DEVELOPMENT

## 2022/2023

### CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Students who complete the module must have acquired the following knowledge, skills and competencies:

#### LEARNING OBJECTIVES

##### KNOWLEDGE

The students should have knowledge of the theories that describe the following areas:

- IT system development.
- Object-oriented programming, visual programming and BIM
- Databases

##### SKILLS

The student should be able to:

- Formulate specific requirements for a small-scale IT system.
- Master the basic techniques of object-oriented programming
- Develop applications by the use of a development tool/environment
- Structuring and modelling of relational databases

##### COMPETENCES

The course provides the students with a capability to:

- Demonstrate a basic understanding of the software development process
- Develop small prototypes of programs.

#### TYPE OF INSTRUCTION

Lectures and exercises in groups supplemented with workshops, presentation seminars and other forms of active learning.

#### EXTENT AND EXPECTED WORKLOAD

The module is 5 ECTS which is corresponding to 150 hours of study.

## EXAM

### EXAMS

Name of exam	IT System Development
Type of exam	Written or oral exam Individual oral or written examination. The exam form is determined at the beginning of the semester.
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	IT systemudvikling
Module code	B-BIC-K2-3
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="#">Kjeld Svidt</a>

## ORGANISATION

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

# **FAULT DETECTION AND DIAGNOSIS IN BUILDINGS**

**2022/2023**

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

The module builds on knowledge corresponding to a BSc degree in Civil Engineering, Indoor Environmental and Energy Engineering or similar and knowledge gained in the course Control and Analysis of Building Energy Systems or similar.

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

### **LEARNING OBJECTIVES**

#### **KNOWLEDGE**

Students who complete the module:

- Must be able to describe the energy system of a building and its interaction with the Building Energy Management Systems (BEMS)
- Must be able to understand the different communication protocols
- Must be able to explain commissioning processes
- Must have knowledge on the different sources of faults in buildings
- Must be able to describe methods and tools for fault detection at the component, subsystem or whole building level (model- and monitoring-based techniques)
- Must be able to perform time series analysis

#### **SKILLS**

Students who complete the module:

- Must be able to use a Building Energy Management System (BEMS)
- Must be able to select a commissioning plan based on risk and cost analysis
- Must be able to detect the sources of faults in buildings
- Must be able to apply fault detection methods and tools based on short-term tests, including Functional Performance Testing (FPT)
- Must be able to apply fault detection methods and tools based on passive monitoring of buildings

#### **COMPETENCES**

Students who complete the module:

- Must be able to combine advanced modelling and measurement techniques to test the performance of components, sub-systems or whole buildings
- Must be able to analyse the energy system of a building and apply in practice different fault detection tools
- Must be able to rank, prioritize and solve faults

#### **TYPE OF INSTRUCTION**

Project work

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

The module is 5 ECTS which is corresponding to 150 hours of study.

## EXAM

### EXAMS

Name of exam	Fault Detection and Diagnosis in Buildings
Type of exam	Written or oral exam The exam is carried out either separately or in connection with the project exam. Form of examination is determined at the beginning of the semester.
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	Detektering af fejl og diagnosticering af bygningen og dens tekniske systemer
Module code	B-IE-K3-15
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="#">Rasmus Lund Jensen</a>

## ORGANISATION

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

# PROJECT-ORIENTED STUDY IN AN EXTERNAL ORGANISATION

**2022/2023**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

Corresponding to the knowledge gained in 1st and 2nd semester or similar.

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

Students who complete the module:

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

#### SKILLS

Students who complete the module:

- 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

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 company's field.
- Must be able to communicate the results of the project work in a project report

#### TYPE OF INSTRUCTION

Project-oriented study in an external organisation and project work. The study board must approve on the content of the project work before the study is commenced.

#### EXTENT AND EXPECTED WORKLOAD

The project module is 30 ECTS which is corresponding to 900 hours of study.

## EXAM

### EXAMS

Name of exam	Project-oriented Study in an External Organisation
Type of exam	Oral exam based on a project 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

## FACTS ABOUT THE MODULE

Danish title	Projektorienteret forløb i en virksomhed
Module code	B-IE-K3-14
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	30
Language of instruction	English
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Rasmus Lund Jensen</a>

## ORGANISATION

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

# MASTER'S THESIS

## 2022/2023

### RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge corresponding to the first two semesters of the master programme.

### 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.

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.

##### EXTENT AND EXPECTED WORKLOAD

Since it is a 50 ECTS project module, the workload is expected to be 1500 hours for the student.

## EXAM

### EXAMS

Name of exam	Master's Thesis
--------------	-----------------

Type of exam	<p>Master's thesis/final project                      Oral exam based on presentation seminar and project rapport.</p> <p>The Master's thesis must include an English summary.* If the project is written in English, the summary can be in Danish.** 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.</p> <p>* Or another foreign language (upon approval from the Board of Studies).</p> <p>** The Board of Studies can grant exemption from this.</p>
ECTS	50
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-IE-K3-16
Module type	Project
Duration	2 semesters
Semester	Autumn
ECTS	50
Language of instruction	English
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Rasmus Lund Jensen</a>
Time allocation for external examiners	D

## ORGANISATION

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



# MASTER'S THESIS

## 2022/2023

### RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge corresponding to the first three semesters of the master programme.

### 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 Oral exam based on presentation seminar and project rapport.

	<p>The Master's thesis must include an English summary.* If the project is written in English, the summary can be in Danish.** 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.</p> <p>* Or another foreign language (upon approval from the Board of Studies).</p> <p>** The Board of Studies can grant exemption from this.</p>
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-IE-K4-15
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	30
Language of instruction	English
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Rasmus Lund Jensen</a>
Time allocation for external examiners	D

## ORGANISATION

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

# ADVANCED MODELLING OF ENERGY TRANSPORT IN BUILDINGS AND HVAC SYSTEMS

**2022/2023**

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

Students who complete the module:

- Must be able to describe the mathematical models for the dynamic conditions of buildings and HVAC systems
- Must be able to explain the analytic and/or numerical solutions of these models
- Must be able to understand how building models and HVAC system models are combined and interact

#### SKILLS

Students who complete the module:

- Must be able to analyse and simulate a thermal system under varying load conditions
- Must be able to apply both simple and advanced calculation methods for analysis and simulation of temperature conditions and heat flows in buildings and elements in HVAC systems under dynamic load conditions
- Must be able to apply experimental methods for verification of the calculated systems
- Must be able to establish proper boundary conditions comprising heat conduction, radiation and convection

#### COMPETENCES

Students who complete the module:

- Must be able to evaluate, optimise and combine models for energy transport in buildings and HVAC systems
- 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 20 ECTS project module, the workload is expected to be 600 hours for the student.

## EXAM

### EXAMS

Name of exam	Advanced Modelling of Energy Transport in Buildings and HVAC Systems
Type of exam	Oral exam based on a project Oral exam based on presentation seminar and project rapport.
ECTS	20
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	Avanceret modellering af energitransport i bygninger og VVS installationer
Module code	B-IE-K3-10
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	20
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Rasmus Lund Jensen</a>

## ORGANISATION

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

# BUILDING COMMISSIONING AND OPERATION

**2022/2023**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge corresponding to 2nd semester and knowledge gained in Control and Analysis of Building Energy Systems and Fault Detection in Buildings or similar.

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

Students who complete the module:

- Must have knowledge about building Commissioning and Operation
- Must have knowledge about standards and state of art within building Commissioning
- Must have knowledge about energy efficient operation of buildings.

#### SKILLS

Students who complete the module:

- Must be able to apply commissioning processes for energy efficient building design and operation
- Must be able to apply, combine and evaluate advanced methods for analysis of the interplay between energy systems, building use, outdoor climate, HVAC systems and Building Management Systems (BEMS)
- Must be able to analyse a building with focus on operation and reduced running cost.

#### 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 Commissioning and Operation of building and its services
- Must be able to optimise the operation of buildings based on measurement and analysis of the performance of the building
- Must be able to handle complex cases related to Commissioning and Operation of energy efficient buildings
- 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 20 ECTS project module, the workload is expected to be 600 hours for the student.

## EXAM

### EXAMS

Name of exam	Building Commissioning and Operation
Type of exam	Oral exam based on a project

	Oral exam based on presentation seminar and project rapport.
ECTS	20
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	Bygningens ibrugtagning og drift
Module code	B-IE-K3-9
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	20
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Rasmus Lund Jensen</a>

## ORGANISATION

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