The Faculty of Engineering and Science
Study Board for Civil Engineering

AALBORG UNIVERSITY
DENMARK

Curriculum for the Master's Program in Building Energy Design

Aalborg University
February 2018

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Campus Aalborg

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Preface

Pursuant to Act 261 of March 18, 2015 on Universities (the University Act) with subsequent changes, the following curriculum is stipulated. The program also follows the Joint Programme Regulations and the Examination Policies and Procedures for the Faculty of Engineering and Science, the Faculty of Medicine and the Technical Faculty of IT and Design.

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Chapter 1: Legal Basis of the Curriculum, etc.

1.1 Basis in ministerial orders
The Master's program is organised in accordance with the Ministry of Higher Education and Science's Order no. 1328 of November 15, 2016 on Bachelor's and Master's Programs at Universities (the Ministerial Order of the Study Programs) and Ministerial Order no. 1062 of June 30, 2016 on University Examinations (the Examination Order). Further reference is made to Ministerial Order no. 111 of January 30, 2017 (the Admission Order) and Ministerial Order no. 114 of February 3, 2015 (the Grading Scale Order) with subsequent changes.

1.2 Faculty affiliation
The Master's program falls under the Faculty of Engineering and Science, Aalborg University.

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

1.4 External Examiners Corps
The Master's programme is associated with the external examiners corps: ingeniøruddannelsernes censorkorps - bygning

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

2.1 Admission

Applicants with a legal right of admission (retskrav):

- Aalborg University offers no bachelor's programmes with a legal right of admission to this Master's program.

Applicants without legal right of admission

Bachelor's programmes qualifying students for admission:

- Bachelor of Science in Civil Engineering; Structural and Civil Engineering, Aalborg University
- Bachelor of Science in Engineering (Civil Engineering with specialisation in Structural and Civil Engineering)
- Bachelor of Science in Civil Engineering; Indoor Environmental and Energy Engineering, Aalborg University
- Bachelor of Science in Engineering (Civil Engineering with specialisation in Indoor Environmental Engineering)
- Bachelor of Science in Civil Engineering; Water and Environment, Aalborg University
- Bachelor of Science (BSc) in Engineering (Civil Engineering with specialisation in Water and Environment)
- Bachelor of Science in Civil Engineering; Transportation Engineering, Aalborg University
- Bachelor of Science (BSc) in Engineering (Civil Engineering with specialisation in Traffic and Highway Engineering)
- Bachelor of Science (BSc) in Engineering (Structural and Civil Engineering), Aalborg University, Campus Esbjerg
- Bachelor of Science (BSc) in Engineering (Mechanical Engineering and Manufacturing), Aalborg University, Campus Aalborg
- Bachelor of Science (BSc) in Engineering (Mechanical Design), Aalborg University, Campus Esbjerg
- Bachelor of Engineering in Civil Engineering, Structural and Civil Engineering, Aalborg University
- Bachelor of Engineering in Civil Engineering; Indoor Environmental and Energy Engineering, Aalborg University
- Bachelor of Engineering in Civil Engineering; Water and Environment, Aalborg University
- Bachelor of Engineering in Civil Engineering; Transportation Engineering, Aalborg University
- Bachelor of Engineering in Civil Engineering, Traffic and Highway Engineering, Aalborg University
- Bachelor of Engineering in Civil Engineering, Aalborg University, Campus Esbjerg
- Bachelor of Engineering in Mechanical Engineering, Aalborg University, Campus Aalborg
- Bachelor of Engineering in Mechanical Engineering, Aalborg University, Campus Esbjerg
- Bachelor of Architectural Technology and Construction Management, University College of Northern Denmark
- Bachelor of Architectural Technology and Construction Management, VIA University College
- Bachelor of Architectural Technology and Construction Management, Erhvervsakademi Sydvest
- Bachelor of Architectural Technology and Construction Management, Erhvervsakademiet Lillebælt
- Bachelor of Architectural Technology and Construction Management, Erhvervsakademi Sjælland
- Bachelor of Architectural Technology and Construction Management, Københavns Erhvervsakademi
- Bachelor of Technology Management and Marine Engineering, MARTEC (Maritime and Polytechnic University College)
- Bachelor of Technology Management and Marine Engineering, Aarhus Maskinmesterskole
- Bachelor of Technology Management and Marine Engineering, Fredericia Makinmesterskole
- Bachelor of Technology Management and Marine Engineering, SIMAX (Svendborg International Maritime Academy)
- Bachelor of Technology Management and Marine Engineering, Maskinmesterskolen København

2.2 Degree designation in Danish and English
The Master's program entitles the graduate to the designation cand.tech. (candidatus/candidata technologiae) i bygningers energidesign. The English designation is: Master of Science (MSc) in Technology (Building Energy Design).

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

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

> **A Candidatus graduate has the following competency profile:**
>
> A Candidatus graduate has competencies that have been acquired via a course of study that has taken place in a research environment.
>
> A Candidatus graduate is qualified for employment on the labour market on the basis of his or her academic discipline as well as for further research (PhD programmes). A Candidatus graduate has, compared to a Bachelor, developed his or her academic knowledge and independence so as to be able to apply scientific theory and method on an independent basis within both an academic and a professional context.

2.5 Competence profile of the program

Knowledge

- Has knowledge in Building Energy Design and Operations that, in Building Energy Design, is based on the highest international research
- Can understand and, on a scientific basis, reflect on the Building Energy Design and Operation's knowledge and identify scientific problems
- Must have knowledge about basic architectural design methodology, the integrated design process and integrated building concepts
- Must understand the relationship between the thermal comfort, indoor air quality and health issues and the heat, moisture, mass and momentum transfer in buildings
- Be able to critically evaluate knowledge and identify new scientific problems within the field of Building Energy Design and Operations
- Must have knowledge about Life cycle cost analysis
- Must have knowledge about Environmental Assessment Methods and Tools

Skills

- Excels in Building Energy Design and Operation's scientific methods and tools and general skills related to employment within consulting engineering
- Can evaluate and select among the Building Energy Design and Operation's scientific theories, methods, tools and general skills and, on a scientific basis, advance new analyses and solutions
- Can communicate research-based knowledge and discuss professional and scientific problems with both peers and non-specialists
- 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, combine and evaluate advanced methods for analysis of the interplay between energy systems, architectural concepts, building design, building use, outdoor climate and HVAC systems
- Be able to apply a wide range of engineering methods in research and development in the field of Building Energy Design and Operations
- Must be able to measure the indoor environmental quality and energy consumption of a building and its systems
- Must be able to apply, combine and evaluate advanced methods for Life cycle cost analysis
- Must be able to apply, combine and evaluate advanced methods for Environmental Assessment Methods and Tools
- Must be able to design buildings using advanced methods at the highest international level

Competencies

- Can manage work and development situations that are complex, unpredictable and require new solutions.
- Can independently initiate and implement discipline-specific and interdisciplinary cooperation and assume professional responsibility.
- Can independently take responsibility for own professional development and specialization
- Can optimise the operation of buildings based on measurement and analysis of the performance of the building
- Can combine, optimise and evaluate models for energy transport in buildings and HVAC systems
- Must be able to handle complex and research-oriented cases related to development of energy efficient buildings
- Be competent to solve new and complicated technical problems by the use of advanced scientific and technological knowledge

- Can design buildings using advanced methods at the highest international level

Chapter 3: Content and Organization of the Program

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

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

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

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

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

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

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

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

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

3.1 Overview of the program

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

Of a total of 120 ECTS, 90-120 ECTS are assessed by the 7-point scale and 45-75 ECTS are assessed by external examination.

Semester		Module	ECTS	Assessment	Exam
1st		Building Energy Use and Indoor Environmental Quality (P)	15	7-point scale	Internal
		Introduction to Problem Based Learning and Models in the Built Environment (C)	5	Pass / fail	Internal
		Introduction to Building Information Management (C)	5	7-point scale	Internal
		Building Heat, Moisture and Energy Modelling (C)	5	7-point scale	Internal
2nd		Building Ventilation, Heating and Cooling (P)	15	7-point scale	External
		Indoor Environmental Analysis and Measurements (C)	5	7-point scale	Internal
		Building Ventilation (C)	5	7-point scale	Internal
		Heating and Cooling Systems (C)	5	7-point scale	Internal
3rd	A[1)]	Building Commissioning Operation and Environmental Impact (P)	15	7-point scale	Internal
		Control and Analysis of Building Energy Systems (C)	5	7-point scale	Internal
		Elective: Environmental Assessment Methods and LCC Analysis	5	7-point scale	Internal
		Elective: Energy Producing and Energy Converting Systems	5	7-point scale	Internal
		Elective: Integrated Building Energy Design	5	7-point scale	Internal
	B	Study at Other University (P/C)	30	-[2)]	-[2)]
4th		Master's Thesis (P)	30	7-point scale	External
3rd-4th		Long Master's Thesis (P) [3)]	45	7-point scale	External
Total			120		

P: Project module, C: Course module

1) 10 ECTS points of course modules on the 3rd semester are elective and the student must choose course credits from the courses listed under 3. semester.
2) Assessment and exam according to the curriculum at the other university.
3) See module description for Master's thesis. By long thesis the Master's thesis is made at the 3rd and 4th semester and is 45 ECTS points plus 15 ECTS points of course modules from A.

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

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

3.2 Building Energy Design 1st semester

3.2.1 Building Energy Use and Indoor Environmental Quality (P)
Bygningens energiforbrug og indeklima

Recommended academic prerequisites:
Introduction to Problem Based Learning and models in the build environment

Objective: Students who complete the module:

Knowledge

- Must be able to understand methods to evaluate the interplay between the indoor environment, heat and moisture transport and energy consumption of a building
- Must have knowledge of essential standards within indoor environment and energy

Skills

- Must be able to apply proper terminology
- Must be able to carry out dimensioning of the building envelope regarding moisture
- Must be able to apply methods to analyse the interplay between the indoor environment, heat and moisture transport
- Must be able to analyse the building envelope in order to minimize the energy consumption
- Must be able to carry through and document energy calculation on a professional level
- Must be able to utilize Building Information Models (BIM) and account for key aspects regarding model co-operation during the design process

Competencies

- Must be able to apply proper terminology in oral, written and graphical communication and documentation of problems and solutions within indoor environment end building energy
- 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 possibly supplemented with instructions, workshops, presentation seminars, lab tests, etc.

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

Evaluation criteria: Are stated in the Joint Programme Regulations.

3.2.2 Introduction to Problem Based Learning and Models in the Built Environment (C)
Introduktion til problembaseret læring og modeller i det byggede miljø

Recommended academic prerequisites:
Corresponding to the admission requirements

Objective: Students who complete the module:

Knowledge

- Must have knowledge and understanding of project organized problem-based learning
- Must have knowledge about group work/conflicts and ways to solve conflicts
- Must have knowledge and comprehension of planning and structuring the documentation of a project
- Must have knowledge about models within the built environment

Skills

- Must be able to apply the project organized learning to actual problem related work in groups
- Must be able to apply systematic methods
- Must be able to apply models within the built environment to problems within the relevant technical area
- Must be able to define goals for the project work and write a conclusion that answers the problem formulation of the project
- Must be able to describe and analyse one or more approaches to the project
- Must be able to apply proper terminology in oral, written and graphical communication and documentation of problems and solutions within relevant technical areas

Competencies

- Independently be able to define and analyse scientific problems
- Must be able to establish, evaluate and reflect on models within the built environment on the essential problems within relevant technical areas
- 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: Lectures, etc. supplemented with project work, workshops, presentation seminars, lab tests

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

Evaluation criteria: Are stated in the Joint Programme Regulations

3.2.3 Introduction to Building Information Management (C)
Introduktion til byggeriets informationshåndtering

Recommended academic prerequisites:
Corresponding to the admission requirements

Objective: Students who complete the module:

Knowledge

- Concepts, technologies and methods to analyse and develop models that describe a building's functional systems and components as well as processes in construction.
- Concepts, techniques and methods to develop product and process models in construction
- Methods for management of knowledge and information in construction, including different types of models and data representation.

Skills

- Explain the fundamental differences between various types of building models and process models.
- Explain central aspects of model supported collaboration between actors of the construction process.
- Demonstrate knowledge of information standards in the field, including classification systems.
- Demonstrate knowledge of significant national and international initiatives regarding the use of information technology in the construction industry.
- Explain the properties of different information representations and their suitability for modelling of different systems.

Competencies

- The course provides students with a number of basic skills to participate in the implementation of ICT-based systems in construction business.

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

Exam format: Individual oral or written examination.

Evaluation criteria: Are stated in the Joint Programme Regulations.

3.2.4 Building Heat, Moisture and Energy Modelling (C)
Energisimulering af bygninger

Recommended academic prerequisites:
Corresponding to the admission requirements

Objective: Students who complete the module:

Knowledge

- Must have knowledge of heat balance of buildings
- Must be able to understand heat and moisture transfer in the building envelope
- Must be able to account for the hygro thermal functional demands regarding materials and constructions used in the building envelope
- Must have knowledge of calculation methodology for building energy use
- Must have knowledge of legislation requirements regarding building energy use
- Must have knowledge of numerical solutions of mathematical problems

Skills

- Must be able to set up hygro thermal functional requirements regarding the building envelope and materials
- Must be able to size the building envelope according to hygro thermal functional demands
- Must be able to conduct a blower door test of a building
- Must be able to set up a steady state heat balance for a building including in and external loads
- Must be able to document the building energy requirements using appropriate methods
- Must be able to perform dynamic simulation of heat flows in building using building energy simulation tools

Competences

- Independently be able to define and analyse scientific problems
- Must be able to apply proper terminology in oral, written and graphical communication and documentation of problems and solutions within sizing the building envelope
- Be able to qualitative quantify the importance of boundary condition, user behaviour and detail level of mathematical models to estimate energy use and indoor environment
- Must be able to discus and evaluate the preconditions and results of building energy use

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

Exam format: Individual oral or written examination

Evaluation criteria: As stated in the Joint Programme Regulations.

3.3 Building Energy Design 2nd semester

3.3.1 Building Ventilation, Heating and Cooling (P)
Bygningens ventilation og installationer

Recommended academic prerequisites:
The module is based upon knowledge obtained at the 1st semester or equivalent

Objective: Students who complete the module:

Knowledge

- Must be able to understand the principles and theories behind planning of HVAC systems
- Must be able to apply methods to analyse the interplay between the indoor environment energy use and HVAC systems
- Must have knowledge of economic calculation of profitability including overall economy consequences of indoor related productivity changes
- Must have knowledge of key standards within building information modelling in the field of HVAC systems

Skills

- Must be able to apply proper terminology
- Must be able to set up functional demands to the indoor environment and HVAC systems of a building
- Must be able to measure the indoor environmental quality and energy consumption of a building and its systems
- Must be able to design the HVAC systems based on an overall consideration to ensure fulfilment of the building code
- Must be able to analyse the building to minimize the energy use by optimizing the HVAC systems and indoor environment level
- Must be able to analyse the financial profitability of the HVAC solution and the entire building design
- Must be able to use BIM in designing and quality assurance of the HVAC systems

Competencies

- Must be able to size the indoor environment and HVAC system of a building
- Must be able to argue for the chosen HVAC system in relation to the level of indoor environment to all parties in the building sector
- 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 possibly supplemented with instructions, workshops, presentation seminars, lab tests, etc.

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

Evaluation criteria: Are stated in the Joint Programme Regulations.

3.3.2 Indoor Environmental Analysis and Measurements (C)
Analyse og måling af indeklima

Recommended academic prerequisites:
The module is based upon knowledge obtained at the 1st semester or equivalent

Objective: Students who complete the module:

Knowledge

- Must have knowledge of functional demands regulatory requirements and standards regarding sizing and measuring the indoor environment
- Must have basic knowledge of the factors influencing the indoor environment and be able to assess the importance of the individual factors importance including adaptive comfort and productivity
- Must have knowledge about measuring and calibration technique within indoor environment and building energy

Skills

- Must be able to conduct an analyse of the interplay between the indoor environment and building energy use
- Must be able to set up functional requirements for the indoor environment
- Must be able to assess the indoor environment according to comfort productivity and energy use
- Must be able to perform relevant measurements of the indoor environment and building energy use

Competencies

- Must be able to participate in a dialogue regarding optimal choice of indoor environment level compared to building type and use
- Must be able to argue for the chosen level of indoor environment to all parties in the building sector
- Must be able to evaluate and reflect on the measured indoor environment and energy use including the used experimental methods and uncertainty of the measurements

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

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

Evaluation criteria: Are stated in the Joint Programme Regulations.

3.3.3 Building Ventilation (C)

Ventilationsteknik

Recommended academic prerequisites:
The module is based upon knowledge obtained at the 1st semester or equivalent

Objective: Students who complete the module:

Knowledge

- Must be able to account for the functional requirements regarding comfort in relation to ventilation
- Must have knowledge about the terminology within ventilation
- Must have knowledge on current standards and regulations within comfort ventilation
- Must be able to understand the theory on mixing and displacement ventilation
- Must have knowledge on natural and hybrid ventilation
- Must have knowledge on design and balancing of duct systems
- Must have knowledge on choice of components for the ventilation unit
- Must have knowledge on noise in relation to ventilation
- Must be able to account in general for the control of ventilation systems
- Must have knowledge on the energy consumption of the individual parts of the ventilation unit
- Must have knowledge on the workflow of a ventilation contract including commissioning and maintenance

Skills

- Must be able to make an reasoned choice of ventilation principle and system based on the functional requirements and relevant loads
- Must be able to equip and size a ventilation system base on performance requirements
- Must be able to perform an impact assessment regarding the energy use of the system and its components
- Must be able to size a ventilation system base don noise requirements

Competencies

- Must be able to reflect on the chosen ventilations solution in relation to functional demands and loads
- Must be able to discus and evaluate the optimal choice of ventilation in relation to outdoor and indoor conditions users and the building

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

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

Evaluation criteria: Are stated in the Joint Programme Regulations.

3.3.4 Heating and Cooling Systems (C)

Varme- og køleteknik

Recommended academic prerequisites:
The module is based upon knowledge obtained at the 1st semester or equivalent

Objective: Students who complete the module:

Knowledge

- Must understand the basics of water and airflows
- Must understand the physical properties and characteristics of liquids and gases
- Must have knowledge on functional requirements regulations and standards regarding heating and cooling systems
- Must be able to account in general for the system layout and control of heating and cooling systems
- Must be able to explain pressure distribution closed pipe systems
- Must have knowledge on sizing heating and cooling systems

Skills

- Must be able to calculate the hydrostatic forces
- Must be able to apply the continuity energy and momentum equations
- Must be able to set up functional requirements for heating and cooling systems
- Must be able to size heating and cooling systems
- Must be able to carry out calculation of pressure losses for closed duct systems including pumps
- Must be able to describe the control of the heating system

Competencies

- Must be able to evaluate different system designs according to a specific building the energy consumption future-orientated maintenance and security of supplies
- Must be able to discus and evaluate the optimal choice of heating and cooling systems

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

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

Evaluation criteria: Are stated in the Joint Programme Regulations.

3.4 Building Energy Design 3rd semester

3.4.1 Building Commissioning Operation and Environmental Impact (P)
Bygningens ibrugtagning drift og miljøpåvirkning

Recommended academic prerequisites:
The module is based upon knowledge obtained at the 2nd semester or equivalent

Objective: Students who complete the module:

Knowledge:

- Must have knowledge about building Commissioning Operation and Environmental impact
- 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, building services and running cost
- Must be able to understand the interplay between microclimate, buildings and operation of their services
- Must be able to understand the interplay between sustainable energy system, building energy demand and renewable energy production

Skills:

- Must be able to apply and combine design methods 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, architectural concepts, building design, building use, outdoor climate and HVAC systems
- Must be able to design a building with focus on operation and reduced running cost

Competencies:

- Must be able to apply proper terminology in oral, written and graphical communication and documentation of problems and solutions within integrated design of buildings and building 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 and research-oriented cases related to development of and running 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 possibly supplemented with instructions, workshops, presentation seminars, lab tests, etc.

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

Evaluation criteria: Are stated in the Joint Programme Regulations.

3.4.2 Control and Analysis of Building Energy Systems (C)
Styring og analyse af bygningers energisystemer

Recommended academic prerequisites:
The module is based upon knowledge obtained at the 2nd semester or equivalent

Objective: Students who complete the module:

Knowledge:

- Must have knowledge on basic control theory, transfer functions, essential strengthening and accuracy of control
- Must have knowledge on feedback control and classical control (P, PI, PID)
- Must have knowledge on models for thermal systems and facilities
- Must have knowledge on state space modelling and control
- Must have knowledge on dynamical modelling and control of HVAC systems

Skills:

- Must be able to perform analysis and simulation of operational conditions of thermal systems and facility functions
- Must be able to setup a numerical model of the control system/design
- Must be able to device and perform control of a building HVAC system
- Must be able to prescribe functional requirements for building systems control

Competencies:

- Must be able to choose and compare different control designs and regulator types
- Must be able to establish evaluate and reflect on control of building energy systems

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

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

Evaluation criteria: Are stated in the Joint Programme Regulations.

3.4.3 Environmental Assessment Methods and LCC Analysis (C)
Bæredygtige vurderingsmetoder og LCC analyse

Recommended academic prerequisites:
The module is based upon knowledge obtained at the 2nd semester or equivalent

Objective: Students who complete the module:

Knowledge:

- Must have knowledge about the design philosophy and calculation methods which can be used to minimize 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, 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 Life Cycle Cost (LCC) analysis
- Must have knowledge about Cost Optimization

Skills:

- Must be able to perform a Life Cycle Assessment (LCA) of a building
- Must be able to evaluate buildings by using assessment and certification methods for high performance buildings
- Must be able to perform a Life Cycle Cost (LCC) analysis of a building
- Must be able to automate basic cost optimisation

Competencies:

- 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 LCA, 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.

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

Evaluation criteria: Are stated in the Joint Programme Regulations.

3.4.4 Integrated Building Energy Design (C)
Integreret energidesign af bygninger

Recommended academic prerequisites:
The module is based upon knowledge obtained at the 2nd semester or equivalent

Objective: Students who complete the module:

Knowledge

- Must have knowledge about the integrated design process
- Must have knowledge about integrated building concepts
- Must have knowledge of basic architectural design methodology
- Must have knowledge of methods for energy efficient building design
- Must have knowledge of passive energy technologies
- Must be able to understand the microclimate around buildings
- Must be able to understand the interplay between microclimate and buildings
- Must be able to describe the calculation methods related to airflow and pressure distribution around buildings
- Must be able to explain the wind and bouyancy driven flows in single zone modelling
- Describe the mathematical models for multizone modelling

Skills

- Must be able to apply basic design methods for passive energy technologies
- Must be able to apply advanced methods for analysis of the interplay between building design, building use and outdoor climate
- Must be able to simulate and analyze the natural airflow of a single zone and a multizone building

Competencies

- Must be able to choose proper modelling of natural and hybrid ventilation in single zone and multizone buildings and discuss inherent model limitations
- Must be able to discuss and reflect on the prospects and limitations of integrated building energy design

Type of instruction: Lectures and exercises in groups supplemented with e.g. workshops, presentation seminars and more.

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

Evaluation criteria: Are stated in the Joint Programme Regulations.

3.4.5 Energy Producing and Energy Converting System
Energiproducerende og -omformende systemer

Recommended academic prerequisites:
The module is based upon knowledge obtained at the 2nd semester or equivalent

Objective: Students who complete the module:

Knowledge

- Must have knowledge about functional requirements and how to estimate load profiles
- Must have knowledge about renewably energy systems in buildings
- Must have knowledge about the construction and principle of operation of solar collectors and photovoltaic systems
- Must have knowledge about thermodynamic cycle in heat pumps and refrigeration cycle of compressors
- Must be able to understand the interplay between different types of energy storage, heat pump systems and typical heating and cooling systems in buildings

Skills

- Must be able to set up functional requirements and load profiles
- Must be able to apply methods to calculate sun path and shade
- Must be able to apply methods to sizing of solar heat, photovoltaic, heat pumps and refrigeration systems

Competencies

- Must be able to evaluate and reflect on the relevance of the individual energy systems in relation to a specific building and its expected energy use
- Must be able to discuss with peers on the proper choice of different types of energy systems

Type of instruction: Lectures and exercises in groups supplemented with e.g. workshops, presentation seminars and more.

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

Evaluation criteria: Are stated in the Joint Programme Regulations.

3.5 Building Energy Design 4th semester

3.5.1 Master's Thesis (P)
Kandidatspeciale

The master's thesis can be conducted as a long master's thesis of 45 ECTS. If choosing to do a long master's thesis, it has to include experimental work and has to be approved by the study board. The amount of experimental work must reflect the allotted ECTS-credits

Objective: Students who complete the module:

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 methods in research and development in the field of specialization
- Be able to communicate relevant scientific and professional aspects of project work in a clear and systematic way both to specialists and the public

Competencies:

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

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

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

Evaluation criteria: Are stated in the Joint Programme Regulations.

Chapter 4: Entry into Force, Interim Provisions and Revision

The curriculum is approved by the Dean of the Faculty of Engineering and Science and enters into force as of 1 February 2018.

Students who wish to complete their studies under the previous curriculum from 2015 must conclude their education by the winter term 2019 at the latest, since examinations under the previous curriculum are not offered after this time.

Chapter 5: Other Provisions

5.1 Rules concerning written work, including the Master's thesis
In the assessment of all written work, regardless of the language it is written in, weight is also given to the student's spelling and formulation ability, in addition to the academic content. Orthographic and grammatical correctness as well as stylistic proficiency are taken as a basis for the evaluation of language performance. Language performance must always be included as an independent dimension of the total evaluation. However, no examination can be assessed as 'Pass' on the basis of language performance alone; similarly, an examination normally cannot be assessed as 'Fail' on the basis of poor language performance alone.

The Board of Studies can grant exemption from this in special cases (e.g., dyslexia or a native language other than Danish).

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

5.2 Rules concerning credit transfer (merit), including the possibility for choice of modules that are part of another program at a university in Denmark or abroad
The Board of Studies can approve successfully completed (passed) program elements from other Master's programs in lieu of program elements in this program (credit transfer). The Board of Studies can also approve successfully completed (passed) program elements from another Danish program or a program outside of Denmark at the same level in lieu of program elements within this curriculum. Decisions on credit transfer are made by the Board of Studies based on an academic assessment. See the Joint Programme Regulations for the rules on credit transfer.

5.3 Rules for examinations
The rules for examinations are stated in the Examination Policies and Procedures published by the Faculty of Engineering and Science on their website.

All students who have not participated in Aalborg University's PBL introductory course during their Bachelor's degree must attend the introductory course "Problem-based Learning and Project Management". The introductory course must be approved before the student can participate in the project exam. For further information, please see the School og Engineering and Science's website.

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

5.5 Rules and requirements concerning the reading of texts
It is assumed that the student can read academic texts in his or her native language as well as English and use reference works, etc. in other European languages

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

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