The Faculty of Engineering and Science
The Study Board of Energy

AALBORG UNIVERSITY
DENMARK

Curriculum for the Bachelor of Science Programme in Applied Industrial Electronics

Aalborg University

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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 programme also follows the Joint Programme Regulations and the Examination Policies and Procedures of 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 Bachelor's programme 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 Programmes at Universities (the Ministerial Order of the Study Programmes) with subsequent changes and Ministerial Order no. 1062 of June 30, 2016 on University Examinations (the Examination Order). Further reference is made to Ministerial Order no. 110 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 Bachelor's programme falls under the Faculty of Engineering and Science, Aalborg University.

1.3 Study Board Affiliation
The Bachelor's programme falls under the Study Board of Energy in the School of Engineering and Science

1.4 External Evaluator Corps
The programme falls under the external evaluator corps: Ingeniøruddannelsernes landsdækkende censorkorps.

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

2.1 Admission
Admission requires an upper secondary education.

According to the Admission Order, the programme's specific entry requirements are:

English B, Mathematics A, and one of the following pair of requirements:

1. Physics B and Chemistry C
2. Physics B and Biotechnology A
3. Geoscience A and Chemistry C

2.2 Degree Designation in Danish and English
The Bachelor's programme entitles the graduate to the designation Bachelor (BSc) i teknisk videnskab (anvendt industriel elektronik). The English designation is: Bachelor of Science (BSc) in Engineering (Applied Industrial Electronics).

2.3 The Programme's Specification in ECTS Credits
The Bachelor's programme is a 3-year, research-based, full-time study programme. The programme is set to 180 ECTS credits.

2.4 Competence Profile on the Diploma
The following will appear on the diploma:

> A graduate of the Bachelor's programme has competences acquired through an educational programme that has taken place in a research environment.

A graduate of the Bachelor's programme has fundamental knowledge about and insight into the methods and scientific foundation of the subjects studied. These competences qualify the graduate of the Bachelor’s programme for further education in a relevant Master’s programme as well as for employment on the basis of the study programme.

2.5 Competence Profile of the Programme

The graduate of the Bachelor’s programme has the following qualifications:

Knowledge

- Knowledge about theory, method and practice in central subject areas within industrial electrical applications
- Understanding of and reflection on theory, method and practice of the subject areas within applied industrial electronics
- Knowledge about and insight into the mathematical foundation in engineering
- Can analyse, design, implement, test and document micro-processor-based systems
- Has knowledge of the interaction between electronic and physical systems, including feedback mechanisms, electronic circuits, automation and control systems, signal processing, power electronics, and electrical machines
- Has insight into analysis, design and test methods for feedback control and digital signal processing systems
- Knowledge about and insight into fundamental control theory, laboratory technology and data acquisition in practice

Skills

- Be able to use up-to-date methods and tools to solve problems within applied industrial electronics and also to apply these skills when employed
- Be able to evaluate theoretical and practical industrial electronic problems and also to give reasons for their choice and select a relevant solution based on set up mathematical, simulation and/or analysis models
- Be able to communicate academic problems and solutions to both peers and non-specialists or collaborative partners and users
- Be able to operate and control units in the applied industrial electronic area
- Be able to make scientific analysis based on results achieved from models or practical measurements on industrial electronic systems

Competences

- Be able to handle complex and development-oriented situations in a study or work context
- Be able to be part of discipline-specific and interdisciplinary cooperation with a professional approach within the industrial electronic area
- Be able to identify own learning needs and structure own learning in different learning environments
- Be able to transfer academic knowledge and skills to problem solving in practice
- At the end of the Bachelor’s programme in Applied Industrial Electronics the graduate has achieved professional competences in planning and operation of industrial electrical systems. The achieved skills enable the graduate to perform design, development,

consultancy and research in Danish and international companies or public institutions. Examples could be energy supply companies, wind energy, machine or process industry and electro-technical companies and consultants.

Chapter 3: Content and Organisation of the Programme

The programme is structured in modules and organised as a problem based study. A module is a programme element or a group of programme 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. Examinations are defined in the curriculum.

The programme is based on a combination of academic, problem oriented and interdisciplinary approaches and organised based on the following types of instruction that combine skills and reflection:

- Lectures
- Class teaching
- Project work
- Workshops
- Exercises (individually and in groups)
- Supervisor feedback
- Professional reflection
- Portfolio work
- Laboratory work

3.1 Overview of the Programme

All modules are assessed through individual grading according to the 7-point grading scale or Passed/Not passed. All modules are assessed by external assessment (an external adjudicator) or by internal assessment (an internal adjudicator or no adjudicator).

Semester	Code	Module	Type	ECTS	Assessment	Exam
1st	BA1-1	Basic Electronic Systems	P	15	7-point grading scale	Internal
	B1-3	Calculus	C	5	7-point grading scale	Internal
	B1-4	Fundamental Energy System Physics and Topology	C	5	Passed/Not passed	Internal
	B1-5	Problem Based Learning in Science, Technology and Society	C	5	Passed/ Not passed	Internal
2nd	BA2-1	Microprocessor Based Systems	P	10	7-point grading scale	External
	B2-2	Introduction to Electrical Engineering	C	5	7-point grading scale	Internal
	B4-4	Real-Time Systems and Programming Languages	C	10	Passed/ Not passed	Internal
	B2-4	Linear Algebra	C	5	7-point grading scale	Internal
3th	BA3-1	Instrumentation	P	15	7-point grading scale	External
	B3-2	AC Circuit Theory	C	5	7-point grading scale	Internal
	B3-3	Applied Engineering Mathematics	C	5	7-point grading scale	Internal
	BA3-2	Signal Processing	C	5	7-point grading	Internal

Semester	Code	Module	Type	ECTS	Assessment scale	Exam
4th	BA 4-1	Control Systems	P	15	7-point grading scale	Internal
	B4-2	Fundamental Control Theory	C	5	7-point grading scale	Internal
	BA4-2	Modelling and Simulation	C	5	7-point grading scale	Internal
	BE6-2	Power Electronics	C	5	7-point grading scale	Internal
5th	BA5-1	Automation including Power Electronics	P	15	7-point grading scale	External
	BE5-2	Modern Digital Control	C	5	7-point grading scale	Internal
	B5-5	Electrical Machines	C	5	7-point grading scale	External
	B5-7	Numerical Methods	C	5	7-point grading scale	Internal
6th	BA6-1	BSc Project: Power Electronics and Electrical Machines (Elective)	P	15	7-point grading scale	External
	BA6-2	Modelling and Control of Robotic Systems (Elective)	P	15	7-point grading scale	External
	B-4-3	Mechanics	C	5	7-point grading scale	Internal
	BA6-3	Modelling and Control of Robot Manipulator	C	5	7-point grading scale	External
	BA6-4	Test and Validation including System Set-up and Understanding	C	5	7-point grading scale	Internal

- P for project and C for course.

Theory of science and scientific methods are included in the project modules (15 ECTS credits) as the project work is based on Problem Based Learning as a scientific method. Besides Problem Based Learning other scientific tools are taught in the course *Problem Based Learning in Science, Technology and Society*.

3.2 Module Descriptions of 1st Semester

3.2.a Project on 1st Semester

Title
BA1-1 Basic Electronic Systems/Basale elektroniske systemer

Objective
After completion of the project the student should:

Knowledge
- Have knowledge about simple basic electronic systems
- Be able to define and understand basic electronic system engineering terms used in the project work and have a fundamental comprehension for the applied methods, theories and/or models in electronics engineering
- Be familiar with working processes applied to project work, acquisition of knowledge and cooperation with the supervisor

Skills
- Be able to define and analyse a subject in basic electronic systems and analyse this subject from one or more angles of approach

- Be able to set up solutions to non-complicated electronic system problems based on an idea generation process
- Be able to communicate coherently the project results in a written, graphical and oral manner
- Be able to analyse personal learning process
- Be able to define the basic electronic engineering and contextual terms used in a project report
- Be able to write a problem analysis and a problem formulation
- Be able to describe the applied theories and methods to analyse the chosen problem in relevant contexts
- Be able to create non-complicated models for the whole, or parts of, the selected electronic system

Competences

- Be able to identify problems in basic electronic systems and reflect upon these in the problem based and project organised form of study
- Be able to communicate the results during the project work in a project report
- Be able to plan and reflect on own experience with project work and problem-solving techniques by applying relevant analysis methods
- Be able to apply methods/theories during the project work in order to analyse an electronic engineering problem

Type of instruction

Project work including supervision. The project work is split in two periods: P0 for problem definition and P1 for problem solving. The first period P0 lasts about 5-6 weeks. The work in the P0 period includes a problem analysis and a problem formulation for the subject to be dealt with in the P1 part of the project. This is documented in a P0 report including also a process analysis for the P0 period. The P0 report is presented in a P0 status and presentation seminar where the project group's documents are discussed.

Based on the problem analysis and problem formulation the students then make a P1 project report where project goals are set up, analyses are performed and results are discussed.

Examination format

Oral examination with internal adjudicator based on the P1 presentation seminar and P1 project report. It is a precondition that the students have handed in a P0 report and participated in the P0 status seminar, to be allowed to participate in the examination of the P1 project.

Assessment criteria

As stated in the Joint Programme Regulations.

3.2.b Course Module on 1st Semester: Calculus

Title

B1-3 Calculus/Calculus

Objective

Students who complete the module should:

Knowledge

- Have knowledge about definitions, results and techniques within the theory of differentiation and integration of functions of two or more variables
- Have knowledge about the trigonometric functions and their inverse functions
- Have knowledge about complex numbers, including computation rules and their representations
- Have knowledge about factorisation of polynomials over the complex numbers
- Have knowledge about the complex exponential function, its characteristics and its connection with

trigonometric functions
- Have knowledge about curves in the plane (in both rectangular and polar coordinates) and spatial parameterisations, tangent vectors and curvatures of such curves
- Have knowledge about the theory of second order linear differential equations with constant coefficients

Skills
- Be able to visualize functions of two and three variables using graphs, level curves and level surfaces
- Be able to determine local and global extrema for functions of two and three variables
- Be able to determine surface area, volume, moment of inertia, etc. using integration theory
- Be able to approximate functions of one variable using Taylor's formula, and to use linear approximations for functions of two or more variables
- Be able to perform arithmetic computations with complex numbers
- Be able to find the roots in the complex quadratic equation and perform factorisation of polynomials in simple cases
- Be able to solve linear second order differential equations with constant coefficients, in general, and with initial conditions
- Be able to reason through the use the concepts, results and theories in simple concrete and abstract problems

Competences
- Be able to develop and strengthen knowledge, comprehension and application within mathematical theories and methods in other subject areas
- Be able to give reasons and to argue on the basis of the given conditions using mathematical concepts from calculus

Type of instruction
Lectures with exercises.

Examination format
Individual, oral or written examination.

Assessment criteria
As stated in the Joint Programme Regulations.

3.2.c Course Module on 1st Semester: Fundamental Energy System Physics and Topology

Title
B1-4 Fundamental Energy System Physics and Topology/Energisystemers grundlæggende fysik og opbygning

Objective
Students who complete the module should:

Knowledge
- Have knowledge and comprehension within energy engineering concepts
- Have knowledge and comprehension within the topology of energy systems
- Have knowledge about major energy machines such as pumps, turbines, heat exchangers, electric motors and generators as well as their functions
- Have knowledge about non-complex energy engineering calculations

- Have gained knowledge about static and quasi static electric and magnetic fields, capacitance and inductance

Skills

- Be able to make fundamental energy and power calculations
- Be able to design a model of a simple energy system
- Be able to set up basic formulas for the processes in major energy machines
- Be able to make basic steady state calculations for energy systems
- Be able to analyse static and quasi static electric and magnetic fields and their propagation
- Be able to use electro physics to determine electric resistance, capacitance and inductance
- Be able to use electro physics to calculate mechanical forces induced by electric and magnetic fields
- Have competences within electric current, electric and magnetic fields, Ampère's law, Faraday's law, Lenz' law, Maxwell's equations and ferromagnetic materials

Competences

- Be able to acquire the terminology of the subject area
- Be able to identify own learning needs and structure own learning in energy engineering systems and electro physics

Type of instruction
Lectures, possibly supported by laboratory experiments and self-study, etc.

Examination format
Individual, oral examination

Assessment criteria
As stated in the Joint Programme Regulations.

3.2.d Course Module on 1st Semester: Problem Based Learning in Science, Technology and Society

Title
B1-5 Problem Based Learning in Science, Technology and Society/Problembaseret læring i videnskab, teknologi og samfund

Objective
Students who complete the module should:

Knowledge

- Be able to explain fundamental teaching theories
- Be able to explain techniques to plan and manage project work
- Be able to explain different approaches to problem based learning (PBL), including the Aalborg Model based on problems related to society and/or humanistic coherence
- Be able to explain different approaches to analysis and judgement of problems and solutions related to engineering, natural and medical science, seen in a scientific, ethic and social perspective
- Be able to describe specific methods within energy engineering to perform such an analysis and assessment

Skills

- Be able to plan and manage a problem-based project work

- Be able to analyse the study group's organisation and cooperation of the project work with regard to identification of the strong and weak sides and on this basis come up with solutions of how to improve teamwork in future groups
- Be able to reflect on the reasons for a group conflict, if any, and come up with possible solutions
- Be able to analyse and evaluate own study and learning effort to identify strong and weak sides, and from this consider the further course of study and study effort
- Be able to reflect on the applied methods in a scientific perspective
- Be able to point out relevant focus, concepts and methods to find and develop solutions considering the social and humanistic coherence in which the solution should be incorporated

Competences
- Be able to enter in a team-based project work
- Be able to document and present the project work
- Be able to reflect and develop own learning
- Be able to enter in and optimize collaborative learning processes
- Be able to reflect on the professional work in relation to the surrounding society

Type of instruction
The course is a mix of lectures, seminars, workshops, group sessions and self-study.

Examination format
The assessment is based on a written exercise handed in individually.

Assessment criteria
As stated in the Joint Programme Regulations.

3.3 Module Descriptions of 2nd Semester

3.3.a Project on 2nd Semester

Title
BA2-1 Microprocessor Based Systems /Mikroprocessor-baserede systemer

Recommended academic prerequisites
The module is based on knowledge achieved in the project module Basic electronic systems or similar.

Objective
After completion of the project, the student should:

Knowledge
- Have knowledge about the fundamentals of embedded systems
- Be able to build and program a microprocessor based system, both in embedded C- and assembly-code
- Must have knowledge of the methodology used for constructing simple connected digital systems, , their use and limitations
- Must have insight of basic terminology for the architecture of microprocessors
- Must have insight of basic terminology for sensor and actuator interface to the microprocessor
- Have knowledge about recognized standards for documentation of electronic circuits.

Skills
- Be able to design an embedded system operating with no human interactions

- Must be able to design a microprocessor program which can runs on its own for controlling the digital/analogue outputs
- Must be able to elaborate a number of possibilities for analysis, program development, programming and testing for the entire microprocessor based system
- Be able to obtain data online using real-time data acquisition
- Be able to synthesize, document and bring the entire system (hardware and software) to working condition

Competences

- Be able to design a microprocessor based system based on the design specifications
- Independently identify and analyze embedded programs
- Independently be able to design and apply embedded programming
- Have a fundamental understanding of timers, counters, interrupts, analog and digital signals, and how these concepts can be applied
- Be able to implement and test the developed system with the purpose of verifying the hypothesis, as well as draw conclusions based on the achieved result.

Type of instruction

Problem based and project oriented project work in groups. The project work is documented in a P2 project report, preparation of a P2 process analysis and participation in a presentation seminar.

Examination format

Oral examination with external adjudicator based on the presentation seminar and project report.

Assessment criteria

As stated in the Joint Programme Regulations.

3.3.b Course Module on 2nd Semester: Introduction to Electrical Engineering

Title

B2-2 Introduction to Electrical Engineering/Elektriske grundfag

Objective

Students who complete the module should:

Knowledge

- Have knowledge and understanding within resistive electrical circuits
- Have knowledge and understanding within operational amplifiers (Op-amps)
- Have knowledge and understanding within inductive and capacitive electrical circuits
- Have knowledge and understanding within electrical measurement techniques
- Have knowledge and understanding within laboratory procedures related with electrical circuits
- Have knowledge about different electrical theorems and laws

Skills

- Be able to analyse simple and complex electrical DC circuits
- Be able to use circuit theory to calculate currents, voltages, energies and powers in DC circuits
- Be able to use circuit reduction methods
- Be able to apply analytical methods to design operational amplifier circuits
- Be able to plan and to implement properly designed electrical circuits in laboratory in a safe and appropriate way
- Be able to use software tools in the design of electrical circuits
- Be able to use software tools for calculating different electrical signals in simple electrical circuits

- Have skills in the following specific topics:
  - Basic DC circuit theory (including energy storing components), Ohms law, units, Kirchhoff laws, circuit reductions (series and parallel), star-delta connections, dependent and independent sources, nodal and loop/mesh methods, basic and ideal operational amplifiers, Thévenin and Norton theorems, superposition, maximum power transfer, first and second order transients
  - Measurement of current, voltage, power and energy, using typical measurement instruments as voltmeter, ampere meter, wattmeter, multi-meter together with oscilloscopes
  - Measurement accuracy and calculation uncertainty
- Be able to use software for calculation of different electrical signals in simple electrical circuits

Competences
- Be able to handle simple development-oriented situations related to electric circuits and laboratory setups in study or work contexts
- Be able to independently engage in disciplinary and interdisciplinary collaboration with a professional approach in the area of basic DC circuit theory
- Be able to identify one´s own learning needs and to structure one's own learning in basic circuit theory and electrical engineering laboratory

Type of instruction
Lectures with exercises and tests. The lectures in connection with laboratory tests are mandatory.

Examination format
Individual, 4-hour written examination.

Assessment criteria
As stated in the Joint Programme Regulations.

3.3.c Course Module on 2nd Semester: Real-Time Systems and Programming Languages

Title
B4-4 Real-Time Systems and Programming Language/Realtidssystemer og programmeringssprog

Objective
Students who complete the module should:

Knowledge
- Have knowledge about number systems (decimal, binary, hexadecimal), basic arithmetic operations and representation of fixed and floating point numbers
- Have knowledge about basic logic gates and simple combinational circuits
- Have basic knowledge about bi-stable components (flip-flops) and their use in simple clocked sequential circuits
- Have an understanding of how digital signals are represented by different electrical logic families including their static and dynamic electrical behaviour
- Have knowledge about general programming methodologies and understand the program development process from problem formulation to final implementation
- Have knowledge about the *C* programming language syntax including memory management, data types and variables, control structures, functions, and the use of pointers
- Have basic knowledge about the *C* language pre-processor, compile and linker process including the use of multiple source files and libraries

- Have knowledge about the use of an integrated development environment for *C* language programming and debugging
- Have a basic understanding about microcontrollers, their architecture and their use in real-time systems
- Have knowledge about fundamental microcontrollers peripheral units such as digital input/output ports and analogue input/output ports
- Have knowledge about the operating principles for digital to analogue converters and analogue to digital converters including their use in practical microcontroller designs
- Have knowledge about special peripheral units including pulse-width modulation and quadrature encoder interface
- Have knowledge about *C*-programming debugging of real-time microcontroller applications with both low-priority background tasks and interrupt service routines
- Have knowledge about implementation of discrete-time filters, controllers and pulse-width modulators
- Have knowledge about graphical programming techniques
- Have knowledge about dataflow programming techniques using basic data types and control structures for both non-deterministic and real-time applications
- Have knowledge about the use of an integrated development environment for graphical programming and debugging
- Have knowledge about hardware solutions for data acquisition systems

Skills

- Be able to analyse, design and realize simple combinatorial and sequential logic circuits
- Be able to outline the main electrical characteristics of logic families and understand when interfacing circuitry is needed
- Be able to interface microcontroller digital and analogue peripherals to external circuits (actuators, sensors, etc.) by taking relevant electrical characteristics into account
- Be able to select a suitable real-time system and programming environment for a particular engineering task
- Be able to divide a programming task into smaller modules that can be programmed and debugged individually
- Be able to develop and test applications using *C* programming and graphical programming that solve a specific task that may require real-time behaviour
- Be able to plan, execute and document laboratory experiments that involve a microcontroller-based real-time system with both analogue and digital inputs and outputs

Competences

- Independently be able to conduct basic design and development within the area of real-time systems and their programming
- Independently be able to extent knowledge and competences within the topic beyond the contents of this course module

Type of instruction
The course is a mix of lectures, workshops, exercises, self-study and mini project.

Examination format
Attendance by at least 80% attendance and approval of mini project that can be completed in groups; scope of approximately 10 pages (maximum of 2800 characters per page).

Assessment criteria
As stated in the Joint Programme Regulations.

3.3.d Course Module on 2nd Semester: Linear Algebra

Title
B2-4 Linear Algebra/Lineær algebra

Objective
Students who complete the module should:

Knowledge

- Have knowledge about definitions, results and techniques in the theory of systems of linear equations
- Be able to demonstrate insight into linear transformations and their connection to matrices
- Have obtained knowledge about the computer program, MATLAB, and its application related to linear algebra
- Have acquired knowledge about simple matrix operations
- Have knowledge about invertible matrices and invertible linear transformation
- Have knowledge about the vector space R^n and its subspaces
- Have knowledge about linearly dependent vectors and linearly independent vectors, and the dimension and basis subspaces
- Have knowledge about the determinant of a matrix
- Have knowledge about eigenvalues and eigenvectors of matrices and their application
- Have knowledge about projections and orthonormal bases
- Have knowledge about first-order differential equations, and systems of linear differential equations

Skills

- Be able to apply theory and calculation techniques for systems of linear equations to determine solvability and determine complete solutions and their structure
- Be able to represent systems of linear equations by means of matrix equations, and vice versa
- Be able to determine and apply the reduced echelon form of a matrix
- Be able to use elementary matrices in connection with Gauss elimination and inversion of matrices
- Be able to determine linear dependence or linear independence of sets of few vectors
- Be able to determine dimension of and basis of subspaces
- Be able to determine the matrix for a given linear transformation, and vice versa
- Be able to solve simple matrix equations
- Be able to calculate the inverse of small matrices
- Be able to determine the dimension of and basis for kernel and column spaces
- Be able to calculate determinants and apply the result of this calculation
- Be able to calculate eigenvalues and eigenvectors for simple matrices
- Be able to determine whether a matrix is diagonalizable, and if so, be able to diagonalize a simple matrix
- Be able to calculate the orthogonal projection onto a subspace of R^n
- Be able to solve separable and linear first order differential equations, in general, and with initial conditions

Competences

- Be able to develop and strengthen knowledge, comprehension and application of mathematical theories and methods in other subject areas
- Given certain pre-conditions, be able to make mathematical deductions and arguments based on concepts from linear algebra

Type of instruction
Lectures and exercises.

Examination format
Individual, oral or written examination.

Assessment criteria
As stated in the Joint Programme Regulations.

3.4 Module Descriptions of 3rd Semester

3.4.a. Project on 3rd Semester

Title
BA3-1 Instrumentation/Instrumentering

Recommended academic prerequisites
The module is based on knowledge achieved in the project module Microprocessor based systems or similar.

Objective
After completion of the project the student should:

Knowledge

- Have knowledge about instrumentation and conditioning of sensors and the conversion of measurement variables into electrical signals.
- Have obtained knowledge about calibration and signal processing for the measurements systems.
- Be able to design and implement sensor and actuator interface hardware to the microprocessor
- Must have knowledge of signal processing of measured data both in real-time and offline.
- Have obtained knowledge of the design of first and second order analogue filters for conditioning of measurements.

Skills

- Be able to understand the importance of signal conditioning and processing for measurement devices.
- Be able to understand the connections and interfaces between microprocessors and sensor and actuator hardware
- Be able to understand the design of analogue filters and their effect on measurements
- Based on the above, be able to create requirements and test specifications that enable the completed system to be tested rigorously
- Be able to design and implement basic analogue and digital circuits and demonstration in laboratory

Competences

-
- Be able to design and implement instrumentation for systems based on demanded specifications
- Independently analyse and implement suitable signal processing algorithms
- Have a fundamental understanding of analogue filters, signal conditioning, data acquisition
- Be able to implement and test the developed system with the purpose of verifying the hypothesis, as well as draw conclusions based on the achieved result.

Type of instruction
Problem-based and project-oriented project work in groups.

Examination format
Oral examination with internal adjudicator based on a presentation seminar and project report.

Assessment criteria
As stated in the Joint Programme Regulations.

3.4.b Course Module on 3rd Semester: AC Circuit Theory

Title
B3-2 AC Circuit Theory/AC-kredsløbsteori

Recommended academic prerequisites
The module is based on knowledge achieved in the module Introduction to electrical engineering or similar.

Objective
Students who complete the module should:

Knowledge

- Have an understanding of:
    - Basic steady-state analysis of AC circuits
    - Basic steady-state power analysis of AC circuits
    - The concepts of mutual inductance, coupling coefficients, the ideal transformer and turns ratio
    - Characteristics for balanced three phase circuits
    - Basic three-phase star and delta-connections
    - Variable frequency behaviour for basic R, L and C circuits
    - Characteristics of basic filters: Low pass, high pass, band pass and band stop
    - Various types of circuit functions
    - Definition of poles and zeros
    - Laplace domain representation of basic circuit elements (including initial conditions): R, L and C
    - Characteristics of diodes and passive single-phase and three-phase rectifiers
    - Fourier techniques for circuit analysis

Skills

- Be able to perform calculations of currents and voltages in steady-state AC circuits
- Be able to perform steady-state power analysis of AC circuits
- Be able to perform calculations on magnetically coupled circuits
- Be able to calculate voltages, currents, powers and power factors in three-phase circuits
- Be able to perform Bode plot and frequency analysis for variable-frequency circuits
- Be able to perform circuit analysis using Laplace transformation
- Be able to design single phase and three phase diode rectifiers
- Be able to perform Fourier analysis of periodic signals in electrical circuits

Competences

- Be able to handle simple development-oriented situations in connection with technical issues of AC circuits in study or work relations
- Be able to perform laboratory work and analyse the results of AC circuit in study and work relations

Type of instruction
Lectures with exercises and laboratory tests.

Examination format
Individual, 4-hour written examination.

Assessment criteria
As stated in the Joint Programme Regulations.

3.4.c Course Module on 3rd Semester: Applied Engineering Mathematics

Title
B3-3 Applied Engineering Mathematics/Anvendt ingeniørmatematik

Recommended academic prerequisites
The module is based on knowledge achieved in the modules Calculus and Linear algebra or similar.

Objective
Students who complete the module should:

Knowledge

- Have knowledge about fundamental methods in vector analysis in the 2 and 3 dimensional space, and have knowledge about applications of the theory to engineering
- Have knowledge about the Laplace transform and how to apply it to solve differential equations exemplified by problems from e.g. mechanics, electronics or heat transfer
- Have knowledge about complex analytic functions
- Have an understanding of power series and Taylor series
- Have an understanding of how complex analytic functions and power series can be applied to study physical systems

Skills

- Be able to use vector calculus, within the topics:
  - Inner product (dot product)
  - Vector product (cross-product)
  - Vector and scalar functions and vector fields
  - Space curves, tangents and arc length
  - Vector differential calculation: Gradient, divergence, curl
  - Vector integral calculation: Line integrals, path independence of line integrals, double integrals, Green's theorem in the plane, and surface integrals
- Be able to apply the theory of Fourier series, within the topics:
  - Fourier series and trigonometric series
  - Periodic functions
  - Even and odd functions
  - Complex Fourier Series
- Be able to apply the theory of Laplace transformations, within the topics:
  - Definition of the Laplace transformation. Inverse transformation. Linearity and s-translation
  - Transformation of elementary functions, including periodic, impulse and step functions
  - Transformation of derivatives and integrals
  - Solution of differential equations
  - Convolution and integral equations
  - Differentiation and integration of transformed systems of ordinary differential equations

- Be able to apply complex analytical functions to conformal mapping and complex integrals within the topics:
    - Complex numbers and the complex plane
    - Polar form of complex numbers
    - Exponential functions
    - Trigonometric and hyperbolic functions
    - Logarithmic functions and general power functions
    - Complex integration: Line integrals in the complex plane
    - Cauchy's integral theorem

Competences

- Be able to use vector calculus, series, Laplace transforms and complex analytic functions to solve fundamental engineering problems.

Type of instruction
The teaching is organised according to the general teaching methods of the study programme, see chapter 3.

Examination format
Individual, 4-hour written examination.

Assessment criteria
As stated in the Joint Programme Regulations.

3.4.d Course Module on 3rd Semester: Signal Processing

Title
BA3-2 Signal Processing/Signalbehandling

Recommended academic prerequisites
The module is based on knowledge achieved in Applied engineering mathematics and Microprocessor based systems (project module).

Objective
Students who complete the module should:

Knowledge

- Have knowledge about analogue signal processing and its application in analysis and design of signals and systems, time and frequency domains
- Have knowledge about sampling theories, embedded systems and methods for processing of physical signals on a computer
- Have knowledge about application and choice of instrument equipment, characteristics and functions
- Have knowledge about Sampling and digitizing of analogue signals.
- Be able to implement IIR filters using bilinear transforms and impulse invariant methods
- Have an understanding of the limitations of taught theories and methods
- Have knowledge about the interplay between analysis of signals in the time and frequency domains
- Have knowledge about basic implementation structures and specific DSP implementation
- Have knowledge about measurement and instrumentation principles

Skills

- Be able to utilize some software tools for analysis, design and simulation of analogue signal processing systems
- Be able to apply theories and methods for spectral estimation including Fourier transform
- Be able to demonstrate the correlation between frequency resolution, window functions and zero-padding
- Be able to apply theories and methods for design of digital filters
- Be able to design FIR filters using windowing methods
- Be able to implement filters in practice, making use of appropriate filter structures, quantization, and scaling.
- Be able to implement embedded system

Competences

- Be able to discuss fundamental theories and methods for analysis and processing of digital signals, using correct terminology
- Be able to assess opportunities and limitations in connection with practical application of taught theories and methods

Type of instruction
As described in the introduction to Chapter 3.

Examination format
Individual written or oral examination.

Assessment criteria
As stated in the Joint Programme Regulations.

3.5 Module Descriptions of 4th Semester

3.5.a. Project on 4th Semester

Title
BA4-1 Control Systems/Styring og regulering

Recommended academic prerequisites
The module is based on knowledge achieved in the project module Instrumentation on the 3rd semester or similar.

Objective
After completion of the project the student should:

Knowledge

- Have insight of transfer functions described via the Laplace formulation, including feature analysis, such as poles, zeros, and analogue/digital implementation
- Have the insight of first-principle modelling and verification by experiments
- Be able to linearize non-linear system models in order to approximate them by linear models
- Have insight into real-time aspects in relation to digital systems communicating with other analogue and/or digital systems

Skills

- Be able to analyse and select methods for modelling of physical systems, such as electric, electro-mechanical, thermal and fluid dynamical systems, or power electronic systems at a level where the resulting models can be utilized in a control system design
- Be able to apply selected modeling techniques for modeling dynamic systems and simulating them

- Be able to analyse the open-loop and closed-loop system features and specify system performances in transfer function descriptions
- Be able to apply basic linear control techniques for analysis and design of a control system based on a given specification

Competences

- Be able to apply different modelling techniques to illustrate dynamic system's features and performance for control design purpose
- Be able to simulate the obtained mathematical model by employing some simulation tools, such as Matlab/Simulink.
- Be able to analyse, design and implement a control solution for a given specific regulation problem, by using fundamental control theories

Type of instruction

Project based, project oriented project work in groups.

Examination format

Oral examination with internal adjudicator based on a presentation seminar and project report.

Assessment criteria

As stated in the Joint Programme Regulations.

3.5.b Course Module on 4th Semester: Fundamental Control Theory

Title

B4-2 Fundamental Control Theory/Grundlæggende regulering

Recommended academic prerequisites

The module is based on knowledge achieved in the modules Calculus, Linear algebra and Applied engineering mathematics or similar

Objective

Students who complete the module should:

Knowledge

- Have knowledge about modelling of physical systems and their dynamics
- Have knowledge about methods for linearisation of non-linear systems
- Have understanding for steady state and transient response of a system, including system order and type and the influence of placement of poles and zeros
- Have understanding of the terms open loop and closed loop
- Be able to understand the frequency response of a system
- Have understanding of absolute and relative stability and methods for analysing the stability of a system
- Have understanding of root locus analysis and knowledge about designing controllers based on root locus techniques
- Have understanding of controller development and design based on frequency response approaches
- Have knowledge about practical implementation of controllers

Skills

- Be able to model and analyse simple dynamical systems (electrical, mechanical and thermal) and understand the analogy between these

- Be able to set up linear models of dynamical systems using block diagrams and transfer functions
- Be able to use elements from control theory to specify performance criteria
- Be able to analyse a systems response and stability using linear methods
- Be able to select suited controllers and predict/evaluate their influence on a given systems response
- Be able to dimension a linear controller for a given system so performance requirements are met
- Be able to judge the problem at hand and the used solution method as well as disseminate results for a technical audience

Competences

- Be able to handle development oriented situations in relation to fundamental control theory and modelling
- Independently be able to participate in professional and multidisciplinary collaboration with a professional approach with regard to fundamental control theory
- Be able to identify own learning needs and structure own learning with regard to fundamental control theory

Type of instruction

The teaching is organised according to the general teaching methods of the study programme, see chapter 3.

Examination format

Individual, written examination.

Assessment criteria

As stated in the Joint Programme Regulations.

3.5.c Course Module on 4th Semester: Modelling and Simulation

Title

BA4-2 Modelling and Simulation/Modellering og simulering

Recommended academic prerequisites

The module is based on knowledge achieved in the module Calculus, Linear Algebra and Applied Engineering Mathematics or similar

Objective

Students who complete the module should:

Knowledge

- Have knowledge about Newton's laws, static equilibrium, rotational motion, moment of force, moment of inertia, linear momentum and angular momentum.
- Have knowledge about the modelling of some typical physical systems, such as mechatronic systems, flow dynamic systems, energy production/transportation/distribution systems, process systems etc., provision of operating conditions
- Have insight into the theoretical modelling for dynamic systems, including the principles of mass balance, energy balance and momentum balance
- Have the knowledge about experimental modelling of linear and non-linear dynamic systems, including the experiment design, data collection, model structure selection, parameter estimation and model validation
- Have insight of linearization techniques of nonlinear systems

- Be able to simulate the obtained mathematical model in some typical simulation environment, such as Matlab/Simulink

Skills

- Be able to solve simple problems within linear and angular motion
- Be able to apply basic theoretical and experimental modelling techniques for modelling dynamic systems and simulating them
- Be able to develop models of dynamic systems in the form of block diagrams and be able to reformulate the equivalent diagrams
- Be able to linearize an obtained nonlinear system and analyse the difference between the linearized and original systems
- Be able to simulate the obtained mathematical model of concerned system and analyse the system features within a proper simulation environment

Competences

- Be able to apply Newton’s laws of motion to simple mechanical systems
- Be able to apply the theoretical modelling approach to model some typical physical systems, with an orientation for control design purpose
- Be able to correctly apply the experimental modelling approach for complicated systems, including the proper experiment design and analysis, selection of model structure and estimation of system parameters, as well as model validation
- Be able to apply Linearization techniques for nonlinear system analysis and simplification
- Be able to identify systems using both white and black box approaches
- Be able to describe dynamic systems in transfer function and state-space formulations

Type of instruction

The teaching is organised according to the general teaching methods of the study programme, see chapter 3.

Examination format

Individual, written or oral examination.

Assessment criteria

As stated in the Joint Programme Regulations.

3.5.d Course Module on 4th Semester: Power Electronics

Title

BE6-2 Power Electronics/Effektelektronik

Recommended academic prerequisites

The module is based on knowledge achieved in the modules Introduction to electrical engineering and AC circuit theory or similar

Objective

Students who complete the module should:

Knowledge

- Have knowledge about theories applied to gain an efficient energy conversion using power electronic systems and apparatus
- Have knowledge about function and operation of power electronic components

- Have knowledge about and understanding of how power electronic systems, appliances and components are modelled
- Have knowledge about modelling tools

Skills

- Be able to apply knowledge about energy efficient power electronic systems, apparatus and their components for simulation
- Be able to evaluate the result of the modelling; to which extent it is representative for the physical world
- Be able to relate to models at different levels of abstraction and their applications

Competences

- Be able to apply academic knowledge and skills in the analysis of efficient power electronic systems, apparatus and their components to a practical problem and to process such a problem
- Be able to engage in disciplinary and interdisciplinary cooperation within power electronic systems

Type of instruction

The teaching is organised according to the general teaching methods of the study programme, see chapter 3.

Examination format

Individual, written examination.

Assessment criteria

As stated in the Joint Programme Regulations.

3.6 Module Descriptions of 5th Semester

3.6.a. Project on 5th Semester

Title

BA5-1 Automation including Power Electronics/Automatisering med anvendt effektelektronik

Recommended academic prerequisites

The module is based on knowledge achieved in the project module Control systems or similar.

Objective

After completion of the project the student should:

Knowledge

- Have insight of sampling mechanism and sampling theorem for an ADC implementation
- Be able to simulate the concerned digital control solution applied to a power electronic system in an efficient and reliable manner
- Be able to deal with real-time issues in a systematic manner when a digital controller is implemented for a power electronic system
- Must have the knowledge of developing state-space model of power electronic systems and their controllers
- Be able to understand and create a business case for the automated power electronic device or system

Skills

- Be able to determine a correct sampling frequency based on the system frequency feature analysis
- Be able to analyse and develop controls for power electronic systems based on derived state-space models
- Be able to handle the real-time issues of digital implementation in a professional manner
- Be able to make a cost-benefit analysis of the automated power electronic system or apparatus

Competences

- Be able to analyse and design a controller in a professional way
- Be able to perform the real-time analysis and programming of the designed controller
- Be able to evaluate the basic economic conditions for the development and commissioning of systems or devices

Type of instruction

Problem based and project oriented work in project groups.

Some lectures are given in business economy to support the objectives in this area.

Examination format

Oral examination with external adjudicator based on a presentation of the project report.

Assessment criteria

As stated in the Joint Programme Regulations.

3.6.b Course Module on 5th Semester: Modern Digital Control

Title

BE5-2 Modern Digital Control/Moderne digital regulering

Recommended academic prerequisites

The module is based on knowledge achieved in the module Fundamental control theory or similar.

Objective

Students who complete the module should:

Knowledge

- Have knowledge about state space models and representation of systems on state space format
- Have knowledge about canonical forms and their connection with transfer functions
- Have knowledge about the systems behaviour and stability properties seen in relation to the eigenvalues of the system
- Have knowledge about controllability and observability
- Have knowledge about pole placement and state observer design
- Have knowledge about sampling and reconstruction of time continuous signals
- Have knowledge about methods for analysis of discrete-time signals and systems using the *Z*-transform
- Have knowledge about methods for design of discrete-time controllers
- Have knowledge about methods for discretization of continuous time controllers

Skills

- Be able to model linear time invariant continuous systems using state space representation
- Be able to solve state space equations and be able to analyse responses and stability properties using state space models
- Be able to design state space controllers and observers for a time continuous system

- Be able to model and analyse both open loop and closed loop discrete time systems
- Be able to select a sampling time
- Be able to formulate specifications for a closed loop system and be able to select a suitable discrete time controller
- Be able to design a discrete time controller in the Z-domain
- Be able to use methods for discretization of a continuous time controllers and be able to evaluate the usefulness of the obtained discrete controller
- Have understanding of the practical implementation of discrete time controllers

Competences

- Be able to handle development oriented situations related to state space control and discrete time control
- Be able to enter into an academic and interdisciplinary cooperation in state space control and discrete time control
- Be able to identify own learning needs and structure own learning related to spate space control and discrete time control

Type of instruction

The teaching is organised according to the general teaching methods of the study programme, see chapter 3.

Examination format

Individual, written examination.

Assessment criteria

As stated in the Joint Programme Regulations.

3.6.c Course Module on 5th Semester: Electrical Machines

Title

B5-5 Electrical Machines/Elektriske maskiner

Recommended academic prerequisites

The module is based on knowledge achieved in the modules Linear algebra, Calculus, Applied engineering mathematics and AC circuit theory or similar

Objective

Students who complete the module should:

Knowledge

- Have basic knowledge about electromagnetic phenomenon, operation and construction of transformers and electrical machines
- Know about flux, flux linkage, phase inductance, mutual inductance and their characteristics
- Have basic knowledge about electromechanical energy conversion
- Have knowledge about three-phase windings and rotating magnetic fields
- Have knowledge about electrical machine material and their characteristics as well as practical application issues, and electrical machine standards
- Have knowledge about transformers, DC, AC and synchronous machines, and the determination of their parameters by tests and construction of steady-state equivalent circuit models under various operating conditions

Skills

- Be able to perform calculations using equivalent circuit models for transformers and electrical machines
- Be able to make necessary simplifications of the transformer equivalent circuit diagram in different applications
- Can draw phasor diagrams for the transformer and electrical machines
- Be able to calculate the power, torque, speed, current, power factor and efficiency of transformers and electrical machines
- Be able to perform experimental tests to determine the desired parameters for transformers and electrical machines

Competences

- Be able to use equivalent circuit diagrams for transformers, synchronous machines, induction machines and analyse their performances under different operating conditions
- Be able to perform laboratory measurements to determine the desired parameters for equivalent circuit diagrams and models
- Be able to handle development specific situations related to the steady-state design, analysis and application of transformers and electrical machines

Type of instruction
Lectures, exercises and laboratory experiments.

Examination format
Individual, 4-hour written examination.

Assessment criteria
As stated in the Joint Programme Regulations.

3.6.d Course Module on 5th Semester: Numerical Methods

Title
B5-7 Numerical Methods/Numeriske metoder

Prerequisites
The module is based on knowledge achieved in the module Applied engineering mathematics or similar.

Objective
Students who complete the module should:

Knowledge

- Comprehend the solution of partial differential equations with analytical methods
- Comprehend different numerical methods
- Comprehend finite difference, finite volume and the Finite Element Method

Skills

- Be able to use analytical methods for solving partial differential equations, including:
  - Separation Method and D'Alembert's principle
- Be able to apply numerical methods for solving mathematical problems, including:
  - Linear equations
  - Gauss elimination
  - Factorization methods
  - Iterative solution of linear equation systems, including Gauss-Seidel

- Ill-conditioned linear equation systems
    - Matrix eigenvalue problems
    - Solution of non-linear equations
    - Interpolation
    - Splines
    - Numerical solution of a definite integral
    - Numerical solution of first order differential equations
    - Numerical solution of second order differential equations
- Be able to apply the finite difference method for solving partial differential equations, including:
    - Difference approximations
    - Elliptic equations
    - Dirichlet and Neumann boundary conditions
    - Parabolic equations
    - Explicit and implicit methods
    - Theta method
    - Hyperbolic equations
    - The use of the Finite Volume Method
- Be able to understand the Finite Element Method for the solution of partial differential equations

Competences

- Be able to handle development-oriented environments involving numerical methods in study or work contexts
- Be able to independently engage in disciplinary and interdisciplinary collaboration with a professional approach within mathematical numerical methods
- Be able to identify own learning needs and to structure own learning in numerical methods

Type of instruction
Lectures and exercises.

Examination format
Individual, oral examination with internal adjudicator.

Assessment criteria
As stated in the Joint Programme Regulations.

3.7 Module Descriptions of 6th Semester

3.7.a. BSc Project on 6th Semester (Elective)

Title
BA6-1 BSc Project: Power Electronics and Electrical Machines/BSc projekt: Effektelektronik og elektriske maskiner

Recommended academic prerequisites
The module is based on knowledge achieved in the project module Automation including power electronics or similar.

Objective
After completion of the project the student should:

Knowledge

- Have knowledge about power electronics, electric drives and controls for applications such as electrical machine, different AC and DC drives and converter systems, etc.
- Have development-based knowledge and understanding within the profession and the discipline's practice and applied theories and methods
- Be able to understand scientific methods and theories compared to the semester theme

Skills

- Be able to apply knowledge about designing electronics and control for applications such as electrical machine, drives and converter systems, etc.
- Be able to apply the discipline's methods and tools and master the skills associated with employment in the profession
- Be able to assess practical and theoretical issues and the reasons for and select the options
- Be able to present practical and professional issues and solutions to partners and user
- Be able to analyse results from simulations and laboratory work, and assemble them to give an overall impression of the system's performance

Competences

- Have the ability to provide robust time and work plans for own project.
- Be able to handle complex and development-oriented situations in study or work contexts within electrical machine and power electronics
- Have the ability to enter into professional and interdisciplinary collaboration with a professional approach in the field as electrical machine and drives and power electronic engineering
- Be able to identify own learning needs and structure learning in different environments in industrial electronics and power electronic engineering
- Be able to translate academic knowledge and skills in the field of industrial electronics and power electronic engineering to a practical problem

Type of instruction

Problem based and project oriented work in project groups.

Examination format

Oral examination with external adjudicator based on a presentation of the project report.

Assessment criteria

As stated in the Joint Programme Regulations.

3.7.b. BSc Project on 6th Semester (Elective)

Title

BA6-2 BSc Project: Modelling and Control of Robotic Systems/BSc project: Modellering og regulering af robot systemer

Recommended academic prerequisites

The module is based on knowledge achieved in the modules Modeling and Control of Robotic Systems, Modelling and simulation, Mechanics, Real Time Systems and Modern digital control or similar

Objective

After completion of the project the student should:

Knowledge

- Have knowledge about robotic systems including its modelling, simulation, control and implementation

- Have development-based knowledge and understanding within the profession and the discipline's practice and applied theories and methods
- Be able to understand scientific methods and theories compared to the semester theme

Skills
- Be able to apply knowledge about modelling and designing robotic systems for different application domains
- Be able to apply the discipline's methods and tools and master the skills associated with employment in the profession
- Be able to assess practical and theoretical issues and the reasons for and select the options
- Be able to present practical and professional issues and solutions to partners and users
- Be able to analyse results from simulations and laboratory work, and assemble them to give an overall impression of the system's performance

Competences
- Have the ability to provide robust time and work plans for own project.
- Be able to handle complex and development-oriented situations in study or work contexts within robotic systems
- Have the ability to enter into professional and interdisciplinary collaboration with a professional approach in the field of robotics
- Be able to identify own learning needs and structure learning in different environments for which robotic systems are designed and applied
- Be able to translate academic knowledge and skills in the field of robotic systems to a practical problem

Type of instruction
Problem based and project oriented work in project groups.

Examination format
Oral examination with external examiner based on a presentation of the project report.

Assessment criteria
As stated in the Joint Programme Regulations.

3.7.c Course Module on 6th Semester: Mechanics

Title
B4-3 Mechanics/Mekanik

Recommended academic prerequisites
The module is based on knowledge achieved in the module Introduction to mechanics and thermodynamics (Curriculum for Bachelor in Energy), or modelling and simulation or similar.

Objective
Students who complete the module should:

Knowledge
- Have an understanding of concepts such as force, moment and static equilibrium
- Have an understanding of the area moments of inertia and mass moments of inertia
- Have an understanding of the kinematics of rigid bodies
- Have an understanding of the kinetics of rigid bodies and systems of bodies in planar motion
- Have knowledge about 3D kinetics of rigid bodies

- Have an understanding of basic solid mechanics, including strain, stress and torsion
- Have an understanding of the stresses in homogeneous beams, rods and shafts, including stress distribution in tension/compression, torsion and bending
- Have knowledge about the deflections of beams under loading

Skills

- Be able to select appropriate supports/end fixings for analysis of mechanical systems and their components
- Be able to analyse rigid planar mechanical structures, both statically and dynamically
- Be able to determine the area moments of inertia and mass moments of inertia of selected elements
- Be able to describe the forces and their action on rigid bodies in 3D
- Be able to analyse strains and stresses in elastic beams under various loading conditions
- Be able to analyse basic cases of deflections of beams

Competences

- Be able to use the acquired skills to the development and analysis of models of mechanical systems
- Be able to use the professional approach to analysis of mechanical systems in academic and interdisciplinary collaboration
- Be able to identify their own learning needs and to structure own learning in mechanical engineering

Type of instruction

The teaching is organised according to the general teaching methods of the study programme, see chapter 3.

Examination format

Individual, written examination.

Assessment criteria

As stated in the Joint Programme Regulations.

3.7.d. Course Module on 6th Semester: Modelling and Control of Robot Manipulator

Title

BA6-2 Modelling and Control of Robot Manipulator/Modellering og regulering af robotter

Recommended academic prerequisites

The module is based on knowledge achieved in the modules Fundamental energy system physics and topology, Modelling and simulation, Mechanics, and Modern digital control or similar.

Objective

Students who complete the module should:

Knowledge

- Have knowledge about the fundamentals of the different robotic systems
- Be able to develop models of robotic systems including actuators and sensors
- Be able to design controllers for considered robots in the presence of uncertain and possibly varying system parameters
- Have knowledge on centralized and distributed control of robot manipulators

Skills

- Be able to analyse system dynamics as basis for controller dimensioning
- Be able to apply the obtained models for linear and non-linear observer designs
- Be able to design both motion and force controllers for robotic systems
- Be able to perform trajectory planning and apply path-following control algorithms

Competences

- Independently identify and analyse robotic systems
- Independently be able to design and apply modelling and control techniques for the robotic automation systems
- Have a fundamental understanding of typical actuators and measurements on the considered systems

Type of instruction

The teaching is organised according to the general teaching methods of the study programme, see chapter 3.

Examination format

Individual, written or oral examination.

Assessment criteria

As stated in the Joint Programme Regulations.

3.7.e. Course Module on 6th Semester: Test and Validation including System Set-up and Understanding

Title

BA6-3 Test and Validation including System Set-up and Understanding/Test og validering inklusiv systemopbygning og -forståelse

Recommended academic prerequisites

The module is based on knowledge achieved in the modules Introduction to Electrical Engineering and Modelling and simulation or similar.

Objective

Students who complete the module should:

Knowledge

- Have knowledge about how different physical systems are built up and interact, this includes for instance understanding of:
  - System division in different layers
  - How to take different time-constants in a system into account
  - How inner control loops affects outer control loops and vise versa
- Have knowledge about what to measure and with which precision, this includes knowledge about
  - Different measurement techniques to be applied
  - Planning and documentation
  - Accuracy
    - analogue versus digital measurements and the combination hereof
  - What affects the accuracy and the resolution of measured signals
- Have knowledge about how to detect signals in noise
  - Mean values and standard deviation

    - Noise and interference, coupling mechanisms

Skills

- Be able to split up a system in different subparts to have better overview of the total system and to understand how the subparts affects each other
    - Physical layers contra data, business and control layers
    - Sub-systems with different time constants
- Be able to calculate the accuracy of a given measurement
- Be able to document a validate a test set up

Competences

- Be able to use the acquired skills for test and validation and understanding of system set ups for different systems and apparatus
- Be able to use the professional approach for test and validation and understanding of system set ups in academic and interdisciplinary collaboration
- Be able to identify their own learning needs and to structure own learning within test and validation
- Be able to understand the difference between test, train, and validation systems

Type of instruction
Lectures, laboratory work and practical exercises.

Examination format
Individual, written or oral examination.

Assessment criteria
As stated in the Joint Programme Regulations.

Chapter 4: Entry into Force, Interim Provisions and Revision

The curriculum is approved by the Dean and enters into force as of 1 September 2018.

Students who wish to complete their studies under the previous curriculum from 2014 (version 2 2017) must conclude their education by the summer examination period 2020 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 Bachelor's Project

In the assessment of all written work, regardless of the language it is written in, weight is also given to the student's formulation and spelling 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 good language performance alone; similarly, an examination normally cannot be assessed as 'Fail' on the basis of poor language performance alone. The Study Board can grant exemption from this in special cases (e.g. dyslexia or a native language other than Danish).

The Bachelor's project 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 (this is not included in any fixed minimum and maximum number of pages per student). 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 Programme at a University in Denmark or Abroad

The Study Board can approve successfully completed (passed) programme elements from other Bachelor's programmes in lieu of programme elements in this programme (credit transfer). The Study Board can also approve successfully completed (passed) programme elements from another Danish programme or a programme outside of Denmark at the same level in lieu of programme elements within this curriculum. Decisions on credit transfer are made by the Study Board based on an academic assessment. See the Joint Programme Regulations for the rules on credit transfer.

5.3 Rules Concerning the Progress of the Bachelor's Programme

The student must participate in all first year examinations by the end of the first year of study in the Bachelor's programme, in order to be able to continue the programme. The first year of study must be passed by the end of the second year of study, in order that the student can continue his/her Bachelor's programme.

In special cases, however, there may be exemption from the above.

5.4 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 of Engineering and Science's website.

5.5 Exemption

In exceptional circumstances, the Study Board 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.

5.6 Rules and Requirements for the Reading of Texts

It is assumed that the student can read academic texts in his or her native language as well as in English and use reference works etc. in relevant languages.

5.7 Additional Information

The current version of the curriculum is published on the Study Board of Energy's website, including more detailed information about the programme, including exams.

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[1] Or another foreign language (French, Spanish or German) upon approval by the Board of Studies.
[2] The Board of Studies can grant exemption from this.