AALBORG UNIVERSITET

BACHELOR (BSC) I TEKNISK VIDENSKAB (ROBOTTEKNOLOGI), 2018

BACHELOR (BSC) I TEKNISK VIDENSKAB
AALBORG

MODULER SOM INDGÅR I STUDIEORDNINGEN

INDHOLDSFORTEGNELSE

TECHNOLOGICAL TEAMWORK (P0)

2019/2020

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

Commencement of Studies Exam

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Through this module, the student shall acquire knowledge about problem oriented and problem based learning. Furthermore, he/she shall acquire first-hand knowledge about project-oriented group work as a learning method. Additionally, the student will be introduced to basic problems and concepts within the field of robotics.

LEARNING OBJECTIVES

KNOWLEDGE

- Must have insight into elementary concepts related to project-oriented group work.
- Must be familiar with the processes involved in project work, knowledge acquisition and supervisor collaboration

SKILLS

- Must be able to define project goals and work in a methodical manner toward achieving such goals
- Must be able to describe and analyse several approaches to project solutions
- Must be able to present results achieved within the project in writing, orally, and graphically in a comprehensive manner

COMPETENCES

- Must be able to reflect upon the problem oriented and problem based learning approach taken throughout the study
- Must be able to document the results achieved during the project in a report
- Must be able to cooperate with other students during the project period and make a joint presentation of the results achieved in the project.
- Must be able to reflect upon different ways of presenting results achieved with the project in writing, orally, and graphically

TYPE OF INSTRUCTION

See the general description of the types of instruction described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	Technological Teamwork
Type of exam	Oral exam based on a project
ECTS	5
Permitted aids	With certain aids: See semester description

Assessment	Passed/Not Passed
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Teknologisk projektarbejde (P0)
Module code	ESNROBB1P1
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

FUNDAMENT MOBILE ROBOTICS (P1)

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Purpose:
A robot is a physical manifestation and mobile robots are one such example. The project takes its starting point in a problem of relevance to society or industry that may be addressed using mobile robotics; the problem is then broken down into smaller, more manageable sub-problems and analysed for the purpose of defining a relevant technical problem formulation, which can be solved via theories and methods related to robotic systems. The solution shall encompass a programmable computer, which is able to measure signals from its surroundings via selected sensors and process them digitally in some form and cause deliberate robotic action via the robots actuators, e.g. wheels. The software can run on the robot platform or remotely via a network.

LEARNING OBJECTIVES

KNOWLEDGE

- Must have an understanding of fundamental robotic systems and their interaction with the environment
- Must have basic insight into concepts such as signals, sensors, mechanics, actuators and computers
- Must have sufficient insight into technological and social issues to enable them to pinpoint relevant problems that can be solved by technical means
- Must have knowledge about common processes in extensive, problem-oriented projects
- Must be able to explain and clarify theories and methods used in the project

SKILLS

- Must be able to identify relevant requirements to a technical solution, product or similar
- Must be able to follow a relevant method for structured development in the project, including formulation and analysis of the problem, define a requirement specification and divide the problem into sub-problems that can be resolved separately
- Must be able to formulate and solve technical problems via algorithms and be able to implement these algorithms in a programmable device the control the robot behaviour
- Must be able to analyse and evaluate their own utilisation of theories and methods outlined above
- Must be able to document and present the knowledge and skills outlined above, using correct terminology, in writing as well as orally
- Must be able to analyse and evaluate their own learning processes using relevant methods
- Must be able to plan and carry out an extensive group project in collaboration with a supervisor

COMPETENCES

- Must understand the general concept of a robot system, in particular pertaining to computation and interacting with the surroundings
- Must be able to assume responsibility for their own learning processes during an extensive group project, as well as generalise and interpret the experience acquired
- Must be able to plan, structure, carry out, and reflect upon a project that starts from a socially or industrially relevant problem, in which robotic systems technology is an important element, individually as well as in groups.
- Must be able to demonstrate a working prototype of their robot

TYPE OF INSTRUCTION

See the general description of the types of instruction described in the introduction to Chapter 3. A minimum of 5 semester lectures are given as support for projects. All groups on the semester participate. The objective is to introduce methodology and knowledge on fundamental robotics in the context of the specific robotics problems that the students are working on in their projects. Sensor and actuator hardware that is supported by ROS packages is introduced, and this serves as a foundation for problem solving in the project.

EXAM

EXAMS

Name of exam	Fundamental Mobile Robotics
Type of exam	Oral exam based on a project Oral examination based on a written report and demonstrations
ECTS	10
Permitted aids	With certain aids: See semester description
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Fundamental mobilrobotik (P1)
Module code	ESNROBB1P2
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	10
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

ROBOT PROGRAMMING

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Purpose:
Students who complete the module should be able to apply development robotic tools, programming languages and SW-environments for solving previously specified tasks in robotics.

LEARNING OBJECTIVES

KNOWLEDGE

- Must have understanding of integrated development environments
- Must have understanding of differences between run-time and compile-time computer programming languages
- Must be able to explain the concepts of types, declarations, expressions and statements
- Must have insight into data structures, such as arrays
- Must have insight into input/output in various forms
- Must have understanding of procedures and functions, including function arguments
- Must have understanding of the complexity of a program
- General imperative programming language (such as C and Java)
- Software environments for robotic programming Robot Operating System (ROS)
- The use of ROS services and package abstractions of sensors, actuators and signals
- Must have understanding of the sharing and collaboration inherent to software frameworks such as ROS

SKILLS

- Must be able to interpret and analyse a basic procedural program and elaborate its functionality
- Must be able to design and implement algorithms for data structure manipulation
- Must be able to explain how to use algorithms, functions and data for solving problems (understanding)
- Must be able to apply at least one specific imperative programming to solve general information processing tasks
- Must be able to apply ROS for solving a specific robot programming task, given sensors and actuators supported by ROS packages

COMPETENCES

- Must be able, individually and in collaboration with others, to design and implement one or more programs to solve a previously specified problems

TYPE OF INSTRUCTION

See the general description of the types of instruction described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	Robot Programming
Type of exam	Written or oral exam
ECTS	5
Assessment	Passed/Not Passed
Type of grading	Internal examination

Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Robot programmering
Module code	ESNROBB1K1
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

PROBLEM BASED LEARNING IN SCIENCE, TECHNOLOGY AND SOCIETY

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Purpose:
To enable the student to approach real-life complex problems in a methodical manner, and to carry out project work, planning and documentation in a structured way.

LEARNING OBJECTIVES

KNOWLEDGE

- Must be able to explain basic learning theory
- Must be able to explain techniques for planning and management of projects
- Must be able to explain different approaches to problem-based learning (PBL), including the so-called Aalborg model based on problems that are part of a social and/or humanistic context
- Must be able to explain different approaches to analysis and assessment of problems and solutions within engineering, natural and health sciences from a theoretical, ethical, and societal perspective
- Must be able to explain how these methods can be applied within robotics

SKILLS

- Must be able to plan and manage a problem-based study project
- Must be able to analyse the project group's organisation and cooperation in order to identify strengths and weaknesses, and suggest how cooperation in future groups can be improved based on this analysis
- Must be able to reflect on the causes and devise possible solutions to any group conflicts
- Must be able to analyse and evaluate their own study work and learning, in order to identify strengths and weaknesses, and use these reflections to consider further study and group work
- Must be able to reflect upon the methods used from a theoretical perspective
- Must be able to identify relevant areas of focus, concepts and methods to assess and develop technical solutions under consideration of the social and humanistic contexts that solution must be a part of

COMPETENCES

- Must be able to take part in a team-based project
- Must be able to document and present work carried out in a project
- Must be able to reflect upon and develop his/her own learning
- Must be able to engage in and improve upon the collaborative learning processes
- Must be able to reflect upon his/her professional activities in relation to the surrounding community

TYPE OF INSTRUCTION

See the general description of the types of instruction described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	Problem Based Learning in Science, Technology and Society
Type of exam	Written or oral exam
ECTS	5

Assessment	Passed/Not Passed
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Problembaseret læring i videnskab, teknologi og samfund
Module code	ESNROBB1K2
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

LINEAR ALGEBRA

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Must have knowledge about definitions, results and techniques within the theory of systems of linear equations
- Must be able to demonstrate insight into linear transformations and their connection with matrices
- Must have acquired knowledge of simple matrix operations
- Must know about invertible matrices and invertible linear mappings
- Must have knowledge of the vector space Rn and various subspaces
- Must have knowledge of linear dependence and independence of vectors and the dimension and bases of subspace
- Must have knowledge of the determinant of matrices
- Must have knowledge of eigenvalues and eigenvectors of matrices and their use
- Must have knowledge of projections and orthonormal bases

SKILLS

- Must be able to use computer software such as Matlab to solve linear algebra problems
- Must be able to apply theory and calculation techniques for systems of linear equations to determine solvability and to provide complete solutions and their structure
- Must be able to represent systems of linear equations using matrix equations, and vice versa
- Must be able to determine and apply the reduced Echelon form of a matrix
- Must be able to use elementary matrices for Gaussian elimination and inversion of matrices
- Must be able to determine linear dependence or linear independence of small sets of vectors
- Must be able to determine the matrix for a given linear transformation, and vice versa
- Must be able to solve simple matrix equations
- Must be able to compute determinants and could use the result of calculation
- Must be able to calculate eigenvalues and eigenvectors for simple matrices
- Must be able to determine whether a matrix is diagonalisable, and if so, implement a diagonalisation for simple matrices
- Must be able to compute the orthogonal projection onto a subspace of Rn
- Must be able to solve separable and linear first order differential equations, in general, and with initial conditions

COMPETENCES

- Must demonstrate development of his/her knowledge of, understanding of, and ability to make use of, mathematical theories and methods within relevant technical fields

TYPE OF INSTRUCTION

Oral or written examination. Exam format is decided on by start of semester.

EXAM

EXAMS

Name of exam	Linear algebra
Type of exam	Written or oral exam
ECTS	5

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

FACTS ABOUT THE MODULE

Danish title	Lineær algebra
Module code	ESNROBB1K3
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

MANIPULATOR AND INDUSTRIAL ROBOTICS

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Purpose:
Through theoretical and practical work on a selected problem, the students acquire knowledge in robotics engineering discipline, as well as use appropriate methods to document that the problem has a relevant social context. The problem is analysed by decomposition into sub problems in order to formulate a technical problem that can be solved by using manipulators or industrial robotics that interact with the environment in one way or another. The complete solution is assessed with respect to the relevant social context. Compared to the first semester, this semester focuses more on the manipulators and industrial robotic aspects.

LEARNING OBJECTIVES

KNOWLEDGE

- Must have gained experience with theories and methods of calculation and simulation of kinematics for robotic manipulators
- Must have acquired knowledge of methods for analysis of linear dynamic systems
- Must have knowledge of relevant coordinate systems and transformations used to describe robot kinematics
- Must have knowledge of recognised standards and terms for documentation of robotic systems
- Must be able to demonstrate knowledge of theory and method to the extent of being able to explain and justify the project's theory and methods, including both selection and de-selection.
- Must be able to use relevant terminology

SKILLS

- Must have understanding of basic theories behind manipulator components such as joints and motors.
- Must be able to identify, analyse and formulate issues within the discipline through the use of contextual and technical analysis methods
- Shall, based on the above, be able to create requirements and test specifications that enable the completed system to be tested rigorously
- Must be able to use mathematical theories and methods to analyse problems involving kinematics
- Must be able to program basic manipulator motion using forward and inverse kinematics
- Must be able to document and disseminate knowledge and skills with proper use of terminology, orally and in writing through a project report
- Must be able to analyse and reflect upon his/her own learning process using appropriate methods of analysis and experience from P0 and P1
- Must be able to analyse a technical-scientific problem under consideration of technological and societal contexts, and assess the technological and social consequences of proposed solutions.

COMPETENCES

- Must be able to demonstrate, independently and in groups, the ability to plan, organise, implement and reflect upon a project that is based on a problem of relevance to society or industry, in which industrial robotics or manipulators play a central role
- Must have acquired, independently and in groups, the ability to obtain the necessary knowledge of a contextual as well as of technical nature, and be able to formulate models of limited parts of reality to such a level of abstraction that the models can be used in the design, implementation and test of a comprehensive system to meet given requirements
- Must be able to evaluate and take responsibility for science and technical solutions in a societal perspective.
- Must be able to generalise and reflect upon the experience with project planning and cooperation for the further study acquired during the project work
- Must be able to solve simple production tasks with an industrial robot.
- Must be able to demonstrate a working prototype of their solution

TYPE OF INSTRUCTION

See the general description of the types of instruction described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	Manipulator and Industrial Robotics
Type of exam	Oral exam based on a project
ECTS	15
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Manipulatorer og industrirobotter
Module code	ESNROBB2P1
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

ROBOT MECHANICS, MODELLING, AND SIMULATION 2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Fundamental aspects related to robot kinematics
- Methods of how to make spatial description of objects
- Basic methodologies for kinematic modelling of robot manipulators
- Principles for kinematic robot simulation
- Transforming task description to robot movements

SKILLS

- Apply homogeneous transformation matrices to represent position and orientation of objects
- Setup the direct and inverse kinematics of a robot
- Design simple trajectory planners, including Cartesian and joint interpolators
- Program an industrial robot to carry out various production tasks
- Transform the task space descriptions to robot movements
- Simulate the kinematic behaviour of a robot

COMPETENCES

- Must be able to program a robot so that the desired kinematic behaviour is obtained.
- Must be able to simulate the kinematics of a robot
- Must be able to solve simple production tasks with an industrial robot.

TYPE OF INSTRUCTION

See the general description of the types of instruction described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	Robot Mechanics, Modelling, and Simulation
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Robot kinematic, modellering og simulering
Module code	ESNROBB2K1
Module type	Course

Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

CALCULUS

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Purpose:
Calculus is the branch of mathematics that studies differential equations and operations such as integration. Differential equations, in turn, describe (among other things) how signals in electric circuits behave

LEARNING OBJECTIVES

KNOWLEDGE

- Must have knowledge on real functions of two or more variables.
- Must have knowledge of the trigonometric functions and their inverse functions
- Most have knowledge of Taylors formula and Taylor series
- Must have knowledge of complex numbers and roots in polynomials
- Must have knowledge of the complex exponential function, its characteristics and its connection with trigonometric functions
- Must have knowledge of curves in the plane (both rectangular and polar coordinates) and spatial parameterisations, tangent vectors and curvatures of such curves
- Must have knowledge of the Laplace transform and its use in relation to solving differential equations.

SKILLS

- Must be able to approximate functions via Taylor series
- Must be able to carry out differentiation of functions of more variables, and have a geometric understanding that allows solution of inhomogeneous second order linear differential equations.

COMPETENCES

- Must be able to solve linear differential equations with constant parameters
- Must be able to solve coupled first order linear differential equations and inhomogeneous second order linear differential equations
- Must be able to give a geometric description of real functions in 2 and 3 variables

TYPE OF INSTRUCTION

See the general description of the types of instruction described in the introduction to Chapter 3.

EXAM

EXAMS

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

FACTS ABOUT THE MODULE

Danish title	Calculus
Module code	ESNROBB2K2
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

STRUCTERED SYSTEM AND PRODUCT DEVELOPMENT

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Purpose:
To give knowledge within methods to perform structured development of systems and products, which includes mechanical components, electronic components and/or software. Here in part methods for the analysis of requirements, concept generation and selection, system definition, decomposition of the system into subsystems, methods for determining the interfaces as well as testing and verification of the established system.

LEARNING OBJECTIVES

KNOWLEDGE

- Must be able to account for different methodologies of product design and development
- Must be able to account for the link between the development process and time scheduling
- Must be able to account for design methods for hardware, software and industrial production
- Must be able to explain demands and specifications in the development process
- Must be able to distinguish between prototype implementation, emulation and simulation
- Must be able to account for black box and white box test methods

SKILLS

- Must be able to develop a requirements specification for a robotic system through an analysis of customer needs
- Must be able to systematically develop and select solution concepts that satisfy requirements specification
- Must be able to identify critical elements of proposed solution concepts
- Must be able to formulate a plan for a project's continuation
- Must be able to formulate verifiable demands for the system and subsystems
- Must be able to formulate and argue for internal and external interfaces
- Must be able to plan and conduct tests and evaluations at sub-system and system level

COMPETENCES

- Must be able to define a system, divide it into sub-systems and to perform integration of the sub-systems
- Must have the ability to systematically develop new products, in particular new robotic systems
- Must be able to evaluate and assess the system verification according to the system demands

TYPE OF INSTRUCTION

See the general description of the types of instruction described in the introduction to Chapter 3

EXAM

EXAMS

Name of exam	Structered System and Product Development
Type of exam	Written or oral exam
ECTS	5
Assessment	Passed/Not Passed
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Struktureret system- og produktudvikling
Module code	ESNROBB2K3
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

MANIPULATING THE SURROUNDINGS

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Purpose:
Many robots are manipulators acting in a known environment, e.g. industrial production. These manipulators often require great accuracy. This project deals with the challenges of manipulating robots and attached tools with the adequate accuracy. To obtain this an understanding of the dynamic characteristic and controller design are essential.

LEARNING OBJECTIVES

KNOWLEDGE

- Must have knowledge about the terminology with robotic manipulation
- Must be able to understand how a particular robotic system, for example the semester project of the student, interacts with the surroundings.

SKILLS

- Must be able to analyse a relevant problem and suggest a solution that uses theories and methods within mechanics, electronic modules, modelling and control.
- Must be able to identify constraints and assessment criteria for a concrete robotic solution.
- Must be able to design and implement a manipulator (or parts thereof).
- Must be able to evaluate the solution with respect to the afore mentioned assessment criteria

COMPETENCES

- Must be able to design robotic mechanisms.
- Must be able to implement control systems using electronic modules as micro controllers.
- Must be able to develop linear models of the dynamic behaviour of manipulators.
- Must be able to select relevant control methods and apply these in a robotic context.
- Must be able to communicate the above (using proper terminology), both orally and in a written report
- Must be able to demonstrate a working prototype of their robot

EXAM

EXAMS

Name of exam	Manipulating the Surroundings
Type of exam	Oral exam based on a project
ECTS	15
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Interaktion med omgivelserne
Module code	ESNROBB3P1

Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

ACTUATORS, DRIVERS AND ELECTRONIC MODULES 2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Students who complete the module should have knowledge about the various building blocks comprising an embedded/robotic control system. The acquired knowledge should be applicable for selecting appropriate components for the design of robotic control systems.

LEARNING OBJECTIVES

KNOWLEDGE

- Must have knowledge of basic electronics: capacitor, diode, and transistor
- Must have knowledge of sensing possibilities: push buttons, potentiometers, photo resistors and force sensitive resistors
- Must have knowledge of limited number of actuators e.g. DC-motors, step-motors, linear actuators
- Must have an overview of the basic structure and behaviour of micro-controllers
- Must have understanding on using micro-controllers: interface to the computer, analogue/digital input/output
- Must have understanding of circuit applications: DC filtering, circuit protection and amplifiers
- Must have knowledge of one particular micro-controller to the level of register-structure, special purpose registers (including timers), I/O including digital, drivers, interrupt channels (level/rising/falling), analogue and digital outputs and PWM)

SKILLS

- To apply acquired knowledge for the design and implementation of robotic control systems

EXAM

EXAMS

Name of exam	Actuators, Drivers and Electronic Modules
Type of exam	Written or oral exam
ECTS	5
Assessment	Passed/Not Passed
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Aktuatorer, driver og elektroniske komponenter
Module code	ESNROBB3K1
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English

Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
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ROBOT DYNAMICS, BIOMECHANICS AND BIOLOGICAL ACTUATORS

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Students who complete the module should have knowledge about the dynamics of the human body and robotic mechanisms. The acquired knowledge should be applicable for designing of industrial robots as well as servicing and rehabilitation robots.

LEARNING OBJECTIVES

KNOWLEDGE

- Must be able to account for key concepts about the human musculoskeletal system, such as cross-bridge theory, different types of muscle contractions, Force-Length-Velocity relationships and different type of joints
- Must be able to account for key concepts from musculoskeletal modelling, such as muscle redundancy, inverse dynamics based estimation of muscle forces and assumptions in these models
- Must be able to explain basic concepts of robotic mechanisms
- Must be able to explain the acceleration of a rigid body, linear and angular accelerations
- Must be able to account for the mass distribution of a rigid body
- Must be able to account for Newton and Euler's equation
- Must be able to explain a Lagrangian formulation of manipulator dynamics

SKILLS

- Must be able to formulate the dynamic equations of robotic mechanisms
- Must be able to simulate and analyse robot motion
- Must be able to apply musculoskeletal modelling techniques on problems within robotics and its interaction with humans.

COMPETENCES

- Must have an in-depth knowledge of robot dynamics which is applicable to the design and control of robotic systems
- Must be able to analyse and select properly robotic mechanisms for desired motion
- Must be able to analyse and critically evaluate the differences and similarities between the biological and robotic movement and actuator system

EXAM

EXAMS

Name of exam	Robot Dynamics, Biomechanics and Biological Actuators
Type of exam	Written or oral exam
ECTS	5
Assessment	Passed/Not Passed
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Robot dynamik, biomekanik og biologiske aktuatorer
Module code	ESNROBB3K2
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
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Faculty	Technical Faculty of IT and Design

ROBOTIC CONTROL SYSTEMS

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Students who complete the module should have knowledge about basic control methodologies and be able to apply them to simple robotic control tasks.

LEARNING OBJECTIVES

KNOWLEDGE

- Must be able to explain the key functionality and system properties provided by a control system
- Must be able to explain input/output systems with disturbances and measurement noise
- Must be able to account for MIMO and SISO systems.
- Must be able account for the key differences between feed forward and feed back control
- Must be able to account for the concepts of stability and instability, including the concepts of poles and zeros for linear systems, the Nyquist stability criterion and root loci

SKILLS

- Must have the ability to identify inputs, outputs and sources of disturbance in a simple robot control system
- Must have the ability to design simple robot control systems based on the acquired knowledge
- Must be able to apply stability analysis to simple robot control systems
- Must be able to apply control design techniques based on open loop characteristics including phase and gain margins
- Must be able to explain PID controllers and apply tuning

COMPETENCES

- Must have the ability to apply relevant terminology from automatic control in the description of robot problems and solutions
- Must have the ability to systematically develop simple control system solutions

EXAM

EXAMS

Name of exam	Robotic Control Systems
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Robot reguleringssystemer
Module code	ESNROBB3K3
Module type	Course

Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

SENSING THE SURROUNDINGS

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Purpose:
In many situations the robot has to operate in a non-static environment, e.g., the robot is mobile or the objects the robot interacts with are in unknown locations and/or configurations. For the robot to be able to operate in such situations it needs to 1) be able to sense its (changing) surroundings and 2) react accordingly. This project module deals with exactly these two challenges

LEARNING OBJECTIVES

KNOWLEDGE

- Must have knowledge about the terminology with robotic sensing
- Must be able to understand how a particular robotic system, for example the semester project of the student, relates to similar system and the surrounding context

SKILLS

- Must be able to analyse a relevant problem and suggest a solution that uses theories and methods within the fields of robot sensing and perception.
- Must be able to identify constraints and assessment criteria for a concrete robotic solution, and (if relevant) its usefulness to society
- Must be able to synthesise, i.e., design and implement, a system (or parts thereof) using a relevant combination of sensing and perception for a concrete robotic scenario
- Must be able to evaluate such a solution with respect to the afore mentioned assessment criteria

COMPETENCES

- Must be able to select appropriate sensors (biological or technical) for a particular robotic task/application
- Must be able to select relevant theories and methods from the fields of robotic sensing and robotic perception and apply these in a new context
- Must be able to communicate the above (using proper terminology), both orally and in a written report
- Must be able to demonstrate a working prototype of their solution

TYPE OF INSTRUCTION

See the general description of the types of instruction described in the introduction to Chapter 3

EXAM

EXAMS

Name of exam	Sensing the Surroundings
Type of exam	Oral exam based on a project
ECTS	15
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Automatisk sansning af omgivelserne
Module code	ESNROBB4P1
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

ROBOTIC SENSING

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

- Must have knowledge about how humans sense their surroundings
- Must have knowledge about human sensors related to, touch, force, vibrations and vision
- Must have knowledge about the electromagnetic spectrum, visual light and how such signals can be captured
- Must have knowledge about intensity-, colour-, thermal- and infrared cameras
- Must be able to understand the critical parameters of a camera (focus, focal-length, depth-of-field, shutter, etc.)
- Must be able to understand how distances can be estimated using different sensors
- Must be able to understand how biological signals from humans can be captured
- The purpose of this course is to equip the student with knowledge and skills within robot sensor technology

LEARNING OBJECTIVES

KNOWLEDGE

- Must be able to apply biological and technical sensors in a gives robotic task/application
- Must be able to select and apply the correct illumination in a given robotic task/application
- Must be able to apply filtering to suppress noise in sensor signals
- Must be able to correct a distorted sensor signal
- Must be able to apply calibration in order to align sensor coordinates and robot coordinates

TYPE OF INSTRUCTION

See the general description of the types of instruction described in the introduction to Chapter 3.

EXAM

EXAMS

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

FACTS ABOUT THE MODULE

Danish title	Robot sansning
Module code	ESNROBB4K1
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English

Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

ROBOTIC PERCEPTION

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Purpose:
The purpose of this course is to equip the student with knowledge and skills about how to analyse the content of data, especially images and video, and how to make decisions based on the analysis.

LEARNING OBJECTIVES

KNOWLEDGE

- Must have knowledge about the building blocks in a generic classification system
- Must have knowledge about different colour representations
- Must be able to understand the principles of point- and neighbourhood processing
- Must be able to understand what a BLOB is and how it can be extracted
- Must be able to understand how moving objects can be segmented in a video sequence
- Must be able to understand the concept of a multidimensional feature-space.
- Must be able to understand the principle behind Bayes rule and how a classifier can be derived here from
- Must be able to understand how to assess a classification system

SKILLS

- Must be able to apply point processing methods like grey-level mapping, histogram stretching, thresholding and image arithmetic
- Must be able to apply neighbourhood processing methods like median filter, mean filter and edge detection
- Must be able to apply morphologic operations like erosion, dilation opening and closing
- Must be able to suggest/select relevant features and methods for extracting these
- Must be able to apply Mahalanobis distance
- Must be able to apply dimensionality reduction methods to a feature space

COMPETENCES

- Must be able to design and implement processing methods to solve a give problem
- Must be able to design and implement a simple classification system

TYPE OF INSTRUCTION

See the general description of the types of instruction described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	Robotic Perception
Type of exam	Written or oral exam
ECTS	5
Assessment	Passed/Not Passed
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Robot perception
Module code	ESNROBB4K2
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

PROBABILITY THEORY AND STATISTICS

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Purpose:
After attending the course the students have developed the engineering intuition of the fundamental concepts and results of probability and statistics. They are able to apply the taught material to model and solve simple engineering problems involving randomness.

LEARNING OBJECTIVES

KNOWLEDGE

- Must have knowledge about the concept of probability spaces
- Must have knowledge about the conceptual models of estimation and hypothesis testing
- Must be able to understand the basic concepts of probability theory, i.e., probability of events, random variables, etc.
- Must be able to understand basic concepts of statistics such as binary hypothesis testing

SKILLS

- Must be able to apply/compute Bayes rule in simple contexts
- Must be able to determine the probability that Binomial, Poisson, and Gaussian random variables take values in a specified interval
- Must be able to determine the mean and variance of Binomial, Poisson, and Gaussian random variables
- Must be able to determine the marginal distributions of multi-variate Gaussian variables
- Must be able to apply and interpret ML-estimation in simple contexts involving the Binomial, Poisson, and Gaussian distribution
- Must be able to apply and interpret binary-hypothesis tests in simple contexts involving the Binomial, Poisson, and Gaussian distribution

COMPETENCES

- Must be able to apply the general concepts of probability theory and statistics in a new, simple context. This includes choosing suitable methods, evaluating outcomes, and making the appropriate conclusions

TYPE OF INSTRUCTION

See the general description of the types of instruction described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	Probability Theory and Statistic
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Sandsynlighedsregning og statistik
Module code	ESNROBB4K3
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

ROBOT INTEGRATION

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Purpose:
A robot is a versatile mechanical device equipped with actuators and sensors under the control of software running on a computer system. Mechanically as well as in software and associated algorithms the individual components must be integrated into one robot system. With the exception of controlled environments, it is generally not realistic to anticipate all motions and actions a robot may have to take to accomplish a requested task. It requires robots to take actions automatically and potentially allows the user to declaratively specify what tasks to have performed, not how.

LEARNING OBJECTIVES

KNOWLEDGE

- Must have an understanding of the interaction between the basic components of a robot system
- Must have an understanding the most common architectures and frameworks for robot control software
- Must have insight into the notion of protocols and data communication used in robot systems
- Must have knowledge of how robots are integrated in a larger context (e.g. in a manufacturing enterprise)

SKILLS

- Must be able to select and use appropriate robotics software frameworks for a specific robotics task
- Must be able to deliberate on the appointment of functionality to components and architectures for hardware and software

COMPETENCES

- Must have the ability to integrate mechanics, sensors, actuators and associated algorithms and architectures to support the control of a robotics problem
- Must have the ability to develop a dynamic model of a robotics problem
- Must have the ability to design and implement controllers to solve a robotics problem
- Must be able to integrate robots in a larger context (e.g. in a manufacturing enterprise)

TYPE OF INSTRUCTION

See the general description of the types of instruction described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	Robot Integration
Type of exam	Oral exam based on a project
ECTS	15
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Robot integration
Module code	ESNROBB5P1
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

SOFTWARE AND AUTOMATION FRAMEWORKS

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Must be able to explain key concepts of networks, including communication protocols and reference models such as OSI and TCP/IP
- Must be able to explain key concept of operating systems, including how programmes communicate internally, access peripheral devices, and handle tasks
- Must have insight into real time aspects of computer software communicating with peripheral devices
- Must be able to explain the fundamentals of typical software systems (e.g. ERP and SCADA systems) found in manufacturing enterprises.
- Must be able to explain the general principles of compilers, parsers and wrappers
- Must be able to explain the general principles and use of PLC's

SKILLS

- Must be able to identify relevant areas of focus, concepts and methods to assess and develop robot applications that involve networks, basic protocols and distributed systems
- Must be able to apply design tools such as compilers, parsers and wrappers
- Must be able to program and interface to a standard PLC

COMPETENCES

- Must be able to design and implement robotic systems that communicate via network(s)
- Must be able to integrate robotic systems with typical software systems (e.g. ERP, SCADA, PLC) found in a manufacturing enterprise

TYPE OF INSTRUCTION

See the general description of the types of instruction described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	Software and Automation Frameworks
Type of exam	Written or oral exam
ECTS	5
Assessment	Passed/Not Passed
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Software og automations frameworks

Module code	ESNROBB5K1
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

PRODUCTIONS SYSTEMS AND AUTOMATION

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

- Must have an understanding of the basic elements and concepts involved in industrial manufacturing
- Must have knowledge about important material transformation processes
- Must have knowledge about main automation building blocks
- Must understand how the building blocks can be combined into an integrated production system
- Must have an understanding of the relationship between product design and automation (design for automation)
- Must have knowledge about safety issues related to the operation of automatic manufacturing systems
- Must understand benefits of automation in product realisation

LEARNING OBJECTIVES

KNOWLEDGE

- Must be able to formulate operational objectives for the performance of an automatic production facility
- Must be able to develop solution concepts that satisfy requirements specification
- Must be able to identify critical elements of proposed solution concepts
- Must be able to design safe automated production system
- Must be able to justify the benefits of an automatic production system

COMPETENCES

- Must be able to interact and communicate with the participants involved in the design, development and operation of manufacturing systems
- Must have gained awareness and a holistic understanding of automatic manufacturing systems and part of running a production facility

TYPE OF INSTRUCTION

See the general description of the types of instruction described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	Productions Systems and Automation
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Produktionssystemer og automation
Module code	ESNROBB5K2
Module type	Course

Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

ROBOTS IN THE HEALTH CARE SYSTEM

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Must be able to account for the ethical aspects related to the use of robotics in the health care system
- Must have knowledge about functional disabilities and their rehabilitation through robotics (e.g. Robotics for Stroke patients, Spinal cord injured patients, etc.)
- Must have knowledge about mental rehabilitation through robotics
- Must have knowledge about robotic control of the human body
- Must have knowledge on the integration of the human body and robots in rehabilitation
- Must have knowledge about haptics and robotics
- Must have knowledge about alternative control methods for assistive robotics (e.g. Brain computer interfaces, tongue computer interfaces and eye based control systems)
- Must have knowledge about service, surgical and social robotics
- Must have knowledge about methods to evaluate the effect of applying robotics in rehabilitation/healthcare

SKILLS

- Must be able to apply knowledge about the functional effects of diseases for the choice of optimal robotic rehabilitation and robotic assistive technologies
- Must be able to apply knowledge about the effects of aging/injury in order to identify relevant robotic assistive technologies
- Must be able to evaluate and apply robotic technologies in health care
- Must be able to advice people in the health care systems about the use of robotics in rehabilitation and assistive technologies

COMPETENCES

See the general description of the types of instruction described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	Robots in the Health Care System
Type of exam	Written or oral exam
ECTS	5
Assessment	Passed/Not Passed
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Robotter i sundhedssystemet
Module code	ESNROBB5K3

Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

MOTION PLANNING AND PATH PLANNING

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Must be able to understand 2D road maps, including visibility graphs and Voronoi diagrams
- Must be able to account for an optimal path in road maps
- Must be able to account for potential fields
- Must be insight into kinematic and holonomic constraints
- Must be able to explain path and trajectory
- Must be able to explain sampling based algorithms

SKILLS

- Must be able define work space and configuration space of rigid objects
- Must be able to construct simplification of configuration spaces
- Must be able to use grid-based search algorithms
- Must be able to use methods and metrics for evaluation of path tracking
- Must be able to do basic feedback control for path and trajectory tracking

COMPETENCES

- Must be able to design and implement motion and path planning algorithms

TYPE OF INSTRUCTION

See the general description of the types of instruction described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	Motion Planning and Path Planning
Type of exam	Written or oral exam
ECTS	5
Assessment	Passed/Not Passed
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Planlægning af bevægelser og vej
Module code	ESNROBB6K1
Module type	Course
Duration	1 semester

Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

BSC PROJECT (ROBOTS IN AN APPLICATION CONTEXT)

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Purpose:
A specific task which potentially can be robotised is selected (e.g. an industrial task, a rehabilitation task, a service task). After the end of the module the student must show capability to develop and present a robotic solution to the task

LEARNING OBJECTIVES

KNOWLEDGE

- Must have knowledge of at least one application area, e.g. robots in health care, industry or entertainment
- Must have knowledge of the scientific basis for the specific application area

SKILLS

- Must be able to make a requirement specification
- Must be able to seek out and develop a solution and present it in the form of sketches, diagrams, drawings and virtual as well as physical prototypes
- Must be able to justify the benefits of the developed solution
- Must be able to independently plan and carry out a development on basis of a given problem
- Must be able to choose and apply relevant methods and tools

COMPETENCES

- Must be able to devise how a relatively complex robotic system could be specified, designed, managed and produced, and in a professional manner to prove this
- Must have the ability to assess important impacts (e.g. economic) aspects of the solution
- Must be able to demonstrate engineering skills within robotics and to display their ability to perform engineering work
- Must be able to take responsibility for their own professional development

TYPE OF INSTRUCTION

See the general description of the types of instruction described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	BSc Project (Robots in an Application Context)
Type of exam	Oral exam based on a project
ECTS	15
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	BSc projekt (Robotter i en applikations sammenhæng)
Module code	ESNROBB6P1
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

BSC PROJECT (ROBOTS IN A THEORETICAL CONTEXT)

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Purpose:
A specific more theoretical problem within robotics is selected (e.g.vision, path planning, human-robot interface).

LEARNING OBJECTIVES

KNOWLEDGE

- One or more topics from the robotics study program are selected for further investigation. After the end of the module the student must show a much deeper understanding of the selected topics.

SKILLS

- Must be able to acquire new in depth knowledge related to selected topics with in robotics
- Must be able to present acquired knowledge in the form of mathematics articles, and virtual as well as physical prototypes
- Must be able to plan and carry out a research study on basis of a specific problem
- Must be able to apply and choose scientific methods and tools to research within the chosen area of knowledge
- Must be able to communicate problems, methods and results within the scientific area, in writing and discuss professional and scientific problems with peers

COMPETENCES

- Must be able to demonstrate scientific skills within robotics and to display their ability to perform scientific work
- Must be able to take responsibility for their own professional development

TYPE OF INSTRUCTION

See the general description of the types of instruction described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	BSc Project (Robots in a Theoretical Context)
Type of exam	Oral exam based on a project
ECTS	15
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	BSc projekt (Robotter i en teoretisk sammenhæng)

Module code	ESNROBB6P2
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

MATRIX COMPUTATIONS AND CONVEX OPTIMIZATION

2019/2020

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge from Linear Algebra / Calculus

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Engineering systems and design problems can often be compactly described analyzed and manipulated using matrices and vectors. Moreover, tractable solutions to design problems can be obtained by casting the design problems as optimization problems. For the class of linear and quadratic problems, the solutions can be obtained by solving systems of equations. In computer programs, this is achieved via matrix factorizations. For the larger class of convex problems, no closed-form solution may exist and numerical methods must be applied. This course aims at teaching numerically robust methods for solving systems of equations and, more generally, convex optimization problems, including also standard constrained problems.

LEARNING OBJECTIVES

KNOWLEDGE

- Knowledge about convex functions and sets, norms, special matrices
- Understand how to classify and solve systems of equations and convex optimization problems
- Understand numerical aspects of solving systems of equations and convex optimization problems
- Knowledge about Lagrange multipliers
- Understand matrix factorizations and their properties

SKILLS

- Identify optimization problems and cast them into standard form
- Identify types of extreme (minima, maxima, local, global, etc.)
- Apply eigenvalue and singular value decomposition to relevant matrix problems
- Have understanding of state space descriptions of systems of linear differential equations
- Apply numerically robust methods to solve systems of equations
- Apply and implement the following numerical optimization methods to unconstrained optimization problems: Steepest Descent, Newton's method, Gauss-Newton method
- Apply and interpret least-squares in solving over-determined systems of equations
- Apply the Lagrange multiplier method to constrained convex optimization problems

COMPETENCES

- Apply linear algebra theory to analyze engineering systems in their field
- State and analyze engineering design problems in their field as systems of equations or standard optimization problems
- Select the appropriate matrix factorization or numerical optimization method to solve engineering design problems in their field

TYPE OF INSTRUCTION

Lectures with exercises. Student projects on engineering application in their field

EXAM

EXAMS

Name of exam	Matrix Computations and Convex Optimization
Type of exam	Written or oral exam
ECTS	5
Assessment	Passed/Not Passed
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Matriksberegning og konveks optimering
Module code	ESNEITB6K2
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	Danish and English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Tatiana Kozlova Madsen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

DESIGN AF INDLEJRET SOFTWARE

2019/2020

FORUDSÆTNINGER/ANBEFALEDE FORUDSÆTNINGER FOR AT DELTAGE I MODULET

Modulet bygger videre på viden opnået i imperativ programmering

MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

Indhold:

- Maskinsprog
- Assembler
- Talteori og talpræcision
- State machines
- System software: compiler, linker og loader
- Drivere
- Kerne / real-time operativ systemer
- Analyse og design af software til indlejrede systemer
- Scheduling:
  - round robin, faste prioriteter
  - kriterier for schedulability
- Introduktion til algoritmer
  - Iteration
  - Induktion
  - Rekursion
- Søgning- og sorterings-algoritmer
  - Arrays
  - Linkede lister
  - Træstrukturer
  - Simple sorterings-algoritmer

LÆRINGSMÅL

VIDEN

- Om et antal forskellige operativ systemer, herunder
  - hvordan programmer kommunikerer internt
  - hvordan periferere enheder tilgåes
  - hvordan jobskift håndteres

FÆRDIGHEDER

- anvende forskellige typer af skeduleringsprincipper
- anvende forskellige typer af interproceskommunikation

KOMPETENCER

- forståelse af design af jobs/programmer, som kan operere optimalt under et givent operativsystem.
- forståelse af design af operativsystemer, hvor der tages højde for f.eks.
  - Hukommelsesforbrug
  - Hukommelsesstørelse
  - Kontekstskiftetid
  - Pipelining
  - Interrupthåndtering
- Design og implementation af softwaresystemer på applikationsniveau

UNDERVISNINGSFORM

Forelæsninger med opgaveregning og selvstudie

EKSAMEN

PRØVER

Prøvens navn	Design af indlejret software
Prøveform	Skriftlig eller mundtlig
ECTS	5
Bedømmelsesform	Bestået/ikke bestået
Censur	Intern prøve
Vurderingskriterier	Vurderingskriterierne er angivet i Universitetets eksamensordning

FAKTA OM MODULET

Engelsk titel	Embedded Software Design
Modulkode	ESNEITB4K2
Modultype	Kursus
Varighed	1 semester
Semester	Forår
ECTS	5
Undervisningssprog	Engelsk
Tomplads	Ja
Undervisningssted	Campus Aalborg
Modulansvarlig	Tatiana Kozlova Madsen

ORGANISATION

Studienævn	Studienævn for Elektronik og IT
Institut	Institut for Elektroniske Systemer
Fakultet	Det Tekniske Fakultet for IT og Design

DIGITAL DESIGN

2019/2020

MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

Formål:
At introducere digitale kredsløb og bevidstgøre den studerende om hele vejen fra basale kredsløb til komplette indlejrede systemer.

LÆRINGSMÅL

VIDEN

- om hvordan gates er opbygget af basale komponenter
- om hvordan man kan regne på boolske udtryk
- om de forskellige muligheder der er for at opbygge et mikrodatamatsystem
- om forskellige platforme hvorpå ens mikrodatamatsystem kan implementeres
- om forskellige syntesesprog, som kan benyttes i designet

FÆRDIGHEDER

- indenfor interfacing til FSM og FSMD blokke, inkl. fra 3. part
- indenfor de til faget hørende elementære byggeblokke, f.eks.
    - Gates
    - Flip-Flops
    - LUT
    - ALU
    - Pipeline
    - Busser og bustyper
- Krav og begrænsninger til interfaces imellem disse blokke, f.eks.
    - Timing
    - Clock skew

KOMPETENCER

- indenfor design af simple FSM og FSMD blokke
- indenfor systemdesign, hvori der indgår et antal IP blokke, som skal interagere

UNDERVISNINGSFORM

Forelæsninger, opgaveregning, workshops, selvstudie

EKSAMEN

PRØVER

Prøvens navn	Digital design
Prøveform	Skriftlig eller mundtlig
ECTS	5
Bedømmelsesform	Bestået/ikke bestået
Censur	Intern prøve
Vurderingskriterier	Vurderingskriterierne er angivet i Universitetets eksamensordning

FAKTA OM MODULET

Engelsk titel	Digital Design
Modulkode	ESNEITB4K1
Modultype	Kursus
Varighed	1 semester
Semester	Forår
ECTS	5
Undervisningssprog	Engelsk
Tomplads	Ja
Undervisningssted	Campus Aalborg
Modulansvarlig	Tatiana Kozlova Madsen

ORGANISATION

Studienævn	Studienævn for Elektronik og IT
Institut	Institut for Elektroniske Systemer
Fakultet	Det Tekniske Fakultet for IT og Design

BIOMEDICAL ENGINEERING IN AN ORGANIZATIONAL AND CORPORATE PERSPECTIVE

2019/2020

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have an understanding of the organization of the healthcare system
- Have an understanding of reimbursement models within the healthcare system
- Have an understanding of regulatory demands on medical equipment
- Have an understanding of the concept behind phase I-IV clinical trials and post-marketing surveillance
- Have an understanding of the principles behind translational research
- Have knowledge about GMP, GLP, and GCP
- Have knowledge about different international norms wrt. equipment within health technology
- Have an understanding of the Quality of Life (QoL) concept and measurement techniques for QoL
- Have an understanding of the quality concept and quality norms
- Have an understanding of procedures regarding protection of intellectual rights
- Have an understanding of copyright issues wrt. for instance user interfaces and the like
- Have an understanding of principles behind project management
- Have an understanding of the organizational structure of businesses within healthcare
- Have an understanding of investment issues
- Have an understanding of business plans

SKILLS

- Will be able to classify medical equipment

TYPE OF INSTRUCTION

Lectures and workshops

EXAM

EXAMS

Name of exam	Biomedical Engineering in an Organizational and Corporate Perspective
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Sundhedsteknologi i organisatorisk og virksomhedsperspektiv
Module code	STIST14B6_5

Module type	Course
Duration	1 semester
Semester	Spring None
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Berit Lund Sørensen

ORGANISATION

Study Board	Board of studies of Sports Science and Public Health
Department	Department of Health Science and Technology
Faculty	The Faculty of Medicine

DIGITAL SIGNALBEHANDLING

2019/2020

FORUDSÆTNINGER/ANBEFALEDE FORUDSÆTNINGER FOR AT DELTAGE I MODULET

Kvalifikationer opnået i kursusmodulerne ”Calculus” og ”Sensorteknologi og -modeller”.

MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

LÆRINGSMÅL

VIDEN

- Kan redegøre for principper, anvendelsesområder og begrænsninger for Diskret-Tid Fourier Transformation (DTFT) og z-transformation

FÆRDIGHEDER

- Kan anvende basale digital signalbehandlingsmetoder til analyse af fysiologiske signaler i både tids- og frekvensdomænet
- Kan designe lineær tids invariante digitale systemer til behandling og håndtering af fysiologiske signaler

EKSAMEN

PRØVER

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

YDERLIGERE INFORMATIONER

Hvis du overvejer at søge ind på uddannelsen, bedes du kontakte den decentrale studievejledning.

Hvis du allerede er indskrevet på et semester, bedes du orientere dig i Moodle og evt. kontakte semesterkoordinator ved faglige spørgsmål eller studiesekretær ved administrative spørgsmål.

Øvrige henvendelser kan rettes til studienævnssekretær Malene Møller Knudsen.

FAKTA OM MODULET

Engelsk titel	Digital Signal Processing
Modulkode	STIST18B4_4
Modultype	Kursus

Varighed	1 semester
Semester	Forår
ECTS	5
Undervisningssprog	Dansk og engelsk
Tomplads	Ja
Undervisningssted	Campus Aalborg
Modulansvarlig	Malene Møller Knudsen

ORGANISATION

Studienævn	Studienævn for Sundhed og Teknologi
Institut	Institut for Medicin og Sundhedsteknologi
Fakultet	Det Sundhedsvidenskabelige Fakultet