AALBORG UNIVERSITET

CIVILINGENIØR, CAND.POLYT. I MEKANIK OG PRODUKTION 2020

CIVILINGENIØR
AALBORG

MODULER SOM INDGÅR I STUDIEORDNINGEN

INDHOLDSFORTEGNELSE

SYSTEM ANALYSIS AND MODELLING

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have gained an in-depth knowledge of theoretical models and methods used for system or system element modelling within the field of mechanical engineering.
- Have gained an in-depth knowledge of experimental techniques used within the field of mechanical engineering.
- Have attained knowledge about the assumptions and limitations of the modelling, simulation and experimental tools used in a project.

SKILLS

- Have attained an understanding of how to select and use suitable mathematical models within their field of specialization.
- Be able to determine the performance of a system or system element using theoretical, numerical and or experimental methods.
- Be able to account for the implementation and practical use of the analytical, numerical, and experimental methods applied in the project.
- Be able to use information technology tools to analyse and design mechanical systems or system elements.
- Be able to use correct terminology.
- Be able to compare theoretical and experimental results.
- Be able to critically evaluate applied methods and their results.
- Construct a project report according to the norms of the scientific field, include relevant original literature
- Use correct academic language and communicate the project's research-based basis and problem and results in a coherent written and oral manner, including the connection between the problem formulation, the project's execution and the main conclusions.
- Evaluate and select relevant original literature and current scientific methods, models and other tools used in the project work, as well as assess the project's problem in relevant technical scientific context.

COMPETENCES

- Be able to analyze a system or system element within their field of specialization.
- Be able to compare theoretical and experimental results carefully, and critically evaluate the methods applied and the results obtained.
- Be able to propose possible improvements on the system or system element from insight obtained from the analysis and modelling.
- Have the ability to design and evaluate a technical solution.
- Plan, implement and manage complex and unpredictable research and / or development tasks and assume a professional responsibility for conducting professional and interdisciplinary collaborations.
- Take responsibility for own academic development and specialization.

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

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

EXAM

EXAMS

Name of exam	System Analysis and Modelling
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	Analyse og modellering af systemer
Module code	M-ME-K1-1A
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	Johnny Jakobsen, Simon Bøgh, Per Johansen

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

FINITE ELEMENT METHODS

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Be able to use the finite element method in static stress analysis.
- Have knowledge of element technology, such as bar, beam, solid and shell elements.
- Be able to solve structural dynamics and vibrations problems using methods such as free vibrations, modal methods and direct time integration methods.
- Be able to apply nonlinear finite element methods including solution of systems of nonlinear equations, geometrically nonlinear problems, contact problems, and nonlinear material models.
- Be able to perform linearised buckling analysis.

SKILLS

- Demonstrate a basic understanding of concepts, theory and applications of finite element analysis from a mechanical engineering view point.
- Be able to perform linear and nonlinear static and dynamic stress analysis using commercial finite element software.
- Be able to conduct a systematic and critical assessment of analysis choices and obtained finite element results.

COMPETENCES

- Be able to apply the concepts, theories and techniques covered in the area of linear and nonlinear finite element analysis on engineering problems using commercial software programs.
- Be able to judge the opportunities and limitations of finite element simulations with regard to engineering problems.

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module the expected workload is 150 hours for the student.

EXAM

EXAMS

Name of exam	Finite Element Methods
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	Elementmetoder
Module code	M-ME-K1-2
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	Erik Lund, Esben Lindgaard

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

SOLID MECHANICS WITH MICROSTRUCTURE

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have gained an understanding of basic mechanical properties of engineering materials and modeling procedures used to quantify these properties, as well as the ways in which these properties characterize material response.

SKILLS

- Be able to understand basic continuum mechanical theories and apply them to simple structural components.
- Be able to substantiate different observable deformation modes by underlying physical mechanisms.
- Be able to document knowledge related to the application of selected analytical/numerical methods for materials characterization.

COMPETENCES

- Have gained an awareness of various responses exhibited by solid engineering materials when subjected to mechanical loadings and an explanation of the physical mechanisms associated with design-limiting behavior of engineering materials.
- Have gained an understanding of predictive analytical and computational frameworks that provide quantitative skills to deal with materials-limiting problems in engineering design.

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module the expected workload is 150 hours for the student.

EXAM

EXAMS

Name of exam	Solid Mechanics with Microstructure
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	Materialemekanik
Module code	M-DMS-K1-3

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

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

FRACTURE MECHANICS AND FATIGUE

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

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

SKILLS

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

COMPETENCES

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

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module the expected workload is 150 hours for the student.

EXAM

EXAMS

Name of exam	Fracture Mechanics and Fatigue
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	Brudmekanik og udmattelse
Module code	M-DMS-K1-4
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Jan Schjødt-Thomsen, Jens Henrik Andreasen

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

SYSTEM DESIGN

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have gained knowledge and understanding of advanced engineering design of mechanical systems and structures.
- Be able to understand and apply advanced analysis tools for evaluating the performance of advanced mechanical systems and structures.
- Understand the fundamental principles of mechanical design and development.

SKILLS

- Be able to apply advanced engineering design on mechanical systems and structures.
- Be able to apply synthesis and analysis in the design process, and demonstrate their interdependence.
- Be able to apply systematic rational design methods.
- Be able to apply advanced analysis theory and tools for optimizing the performance of a mechanical system.
- Be able to develop a requirements specification for a mechanical system through an analysis of customer needs.
- Be able to develop solution concepts that satisfy requirements specification.
- Be able to identify critical elements of proposed solution concepts.
- Be able to use appropriate modelling and simulation tools for developing solutions.
- Construct a project report according to the norms of the scientific field, include relevant original literature.
- Use correct academic language and communicate the project's research-based basis and problem and results in a coherent written and oral manner, including the connection between the problem formulation, the project's execution and the main conclusions.
- Evaluate and select relevant original literature and current scientific methods, models and other tools used in the project work, as well as assess the project's problem in relevant technical scientific context.

COMPETENCES

- Be able to design solutions for a mechanical problem, with an industrial partner or with industrial relevance.
- Be able to consider a problem of sufficient complexity to encompass the use of advanced analytical, numerical or experimental analysis tools for predicting the performance of the mechanical system or structure during operation.
- Be able to document a final design with respect to performance using virtual prototypes or analytical models, and include manufacturing considerations.
- Be able to handle a multidisciplinary problem of high complexity that requires use of both the understanding of the innovative process of mechanical design methodology and new design methods.
- Be able to professionally participate in the development of new mechanical systems, focusing on the evaluation, selection and implementation of relevant technologies.
- Establish the foundation for applying advanced and relevant simulation tools for future research and development activities.
- Plan, implement and manage complex and unpredictable research and / or development tasks and assume a professional responsibility for conducting professional and interdisciplinary collaborations.
- Take responsibility for own academic development and specialization.

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

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

EXAM

PREREQUISITE FOR ENROLLMENT FOR THE EXAM

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

EXAMS

Name of exam	System Design
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	Systemdesign
Module code	M-ME-K2-1A
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	Jørgen Asbøll Kepler, Peter Omand Rasmussen, Simon Bøgh

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

ENGINEERING OPTIMIZATION – CONCEPTS, METHODS AND APPLICATIONS

2021/2022

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module adds to the knowledge obtained in 1st Semester.

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have gained an in-depth understanding of important concepts and methods of optimization for efficient solution of optimization problems within different areas of engineering, including design optimization of mechanical systems.

SKILLS

- Be able to use optimization concepts and topics.
- Be able to use numerical methods of unconstrained optimization.
- Be able to use numerical (mathematical programming) methods for optimization of multi-dimensional functions with constraints.
- Be able to solve multicriterion optimization problems.
- Be able to apply other methods of optimization, such as integer problems, response surface methods, genetic algorithms, etc.
- Be able to perform general applications of optimization methods: parameter identification, optimization as an analysis tool for problems governed by an extremum principle, surrogate and metamodelling problems.

COMPETENCES

- Be able to apply the concepts, theories and methods for solution of engineering optimization problems.
- Be able to account for the considerations involved in the process of formulating and modeling an engineering optimization problem, choosing an advantageous method of solution, and implementing it in practice.

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module the expected workload is 150 hours for the student.

EXAM

EXAMS

Name of exam	Engineering Optimization – Concepts, Methods and Applications
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	Ingeniørmæssig optimering – begreber, metoder og anvendelser
Module code	M-DMS-K2-2
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	Erik Lund

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

MECHANICS OF COMPOSITE MATERIALS AND STRUCTURES

2021/2022

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module adds to the knowledge obtained in 1st Semester.

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have gained an in-depth understanding of the overall topical area of composite materials including their properties, manufacturing, analysis and design.
- Be able to document understanding of the following concepts and theories:
  - Applications of composites.
  - Fibers and polymer resin materials: Types and properties.
  - Manufacturing methods, their processing characteristics and influence on the mechanical properties of composites.
  - Laminae and laminates: Micro-mechanical models, modeling of the laminae, classical lamination theory (CLT).
  - Analysis of composite structures: Beam, plate and shell modeling.
  - Thermal effects.
  - Fracture and failure.
  - Sandwich structures.
  - Adhesive bonded and mechanical joints, load introduction aspects, 3D effects and general principles for design.
  - Finite element analysis of laminated composite structures.

SKILLS

- Be able to apply concepts, theories and methods for analysis and design of composite materials and complex structures made from composite materials to real-life problems.

COMPETENCES

- Be able to undertake development and product design using composite materials.
- Be able to develop procedures for production and verification of components made from composite materials.

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module the expected workload is 150 hours for the student.

EXAM

EXAMS

Name of exam	Mechanics of Composite Materials and Structures
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	Kompositmaterialers og -konstruktioners mekanik
Module code	M-DMS-K2-3
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	Jørgen Asbøll Kepler, Johnny Jakobsen, Erik Lund

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

ENERGY AND VARIATIONAL METHODS WITH APPLICATIONS

2021/2022

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module adds to the knowledge obtained in 1st Semester.

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have gained an in-depth understanding of energy and variational methods and classical principles of stationarity to derive governing equations of statics and dynamics, and their application for solution of general problems in structural mechanics, including:
  - Energy methods and energy minimization principles as the foundation of the finite element method
  - Variational methods (methods of Ritz, Galerkin, Rayleigh and Rayleigh-Ritz)
  - Different applications of those such as analysis of statics, buckling and vibration of beams, plates and similar
  - Dynamics of discrete multi-dof and multi-body mechanical systems
  - Exact and approximate solutions to the natural frequencies and modal analysis problems for multi-dof/continuous vibration systems
- Approximate methods for nonlinear mechanical vibrations

SKILLS

- Be able to apply energy and variational methods for the solution of problems in statics and dynamics involving discrete and continuous, multi-rigid-body and multi-dof vibrational mechanical systems
- Be able to adequately simulate and analyze dynamics of linear and non-linear mechanical systems

COMPETENCES

- Be able to apply energy minimization / maximization principles to derive the relationships between stresses, strains, displacements, material properties, and external effects (e.g., tractions and volume forces) in the form of balance of the kinetic and potential energies and the work done by internal and external forces.
- Be able to use the variational calculus as a convenient and robust tool for formulating the governing equations of statics and dynamics of rigid and solid bodies in applied mechanics.
- Be able to apply the energy and variational methods to find approximate analytical and numerical (e.g. finite element) solutions of complex problems in statics, stability and dynamics of mechanical systems
- Be able to formulate equations of motion for multi-body mechanical systems and for discrete multi-dof and continuous vibration systems using Lagrange and Newton-Euler equations.
- Be able to understand and analyze the dynamic behavior (mode shapes and eigenfrequencies) of linear vibration systems
- Be able to use appropriate (e.g., harmonic balance) methods to analyze behavior of nonlinear vibration systems.

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module the expected workload is 150 hours for the student.

EXAM

EXAMS

Name of exam	Energy and Variational Methods with Applications
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	Energi- og variationsmetoder med anvendelser
Module code	M-DMS-K2-4
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	Sergey Sorokin

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

INDUSTRIAL DEVELOPMENT

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Hold knowledge of analytical, numerical and/or experimental methods for analysis of advanced tasks within the field of specialization.
- Understand the connection between engineering and scientific theory and their application in practical problems.
- Explain the scientific basis and scientific issues within the specialization.
- Explain the highest international research in the field of specialization.

SKILLS

- Be able to apply analytical, numerical and/or experimental methods for analysis and solving of advanced tasks within the field of specialization.
- Be able to apply relevant theory to field specific applications.
- Be able to solve advanced engineering tasks within the field of specialization.
- Be able to compare and evaluate assumptions, limitations and uncertainties related to the methods applied in connection to finding solutions of advanced challenges within the field of specialization.
- Master the scientific methods and general skills related to the field of specialization.
- Compose a project report according to the field's norms, use correct professional language, document extensive inclusion of relevant original literature, communicate and discuss the project's research-based basis and problem and results in a written, graphic and oral manner in a coherent way.
- Critically evaluate the project's results in relation to relevant original literature and current scientific methods, models and evaluate and discuss the project's problem in a relevant technical scientific context.
- Assess and put the project's potential into perspective for further development.

COMPETENCES

- Be able to handle development-oriented situations in connection to either studying or working.
- Be able to analyse and solve an actual problem of industrial relevance through application of systematic research and development processes, including advanced analytical, experimental and/or numerical methods and models.
- Be able to use the correct terminology in oral, written or graphical communication and documentation of challenges and solutions within the field of specialization.
- Participate in and independently carry out technological development and research, as well as solve complex tasks using scientific methods.
- Perform planning, implementation and management of complex and unpredictable research and / or development tasks and assume a professional responsibility for completing independent academic tasks as well as interdisciplinary collaborations.
- Independently take responsibility for own professional development and specialization.

TYPE OF INSTRUCTION

The project work is carried out as an independent work process in which the students themselves organize and coordinate their workload in collaboration with a supervisor.

The project may be carried out individually or in groups.

EXTENT AND EXPECTED WORKLOAD

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

EXAM

EXAMS

Name of exam	Industrial Development
Type of exam	Oral exam based on a project
ECTS	30
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Industrielt udviklingsarbejde
Module code	M-ME-K3-1A
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	30
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Torben Ole Andersen, Simon Bøgh, Sergey Sorokin

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

INDUSTRIAL DEVELOPMENT

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Hold knowledge of analytical, numerical and/or experimental methods for analysis of advanced tasks within the field of specialization.
- Understand the connection between engineering and scientific theory and their application in practical problems.
- Explain the scientific basis and scientific issues within the specialization.
- Explain the highest international research in the field of specialization.

SKILLS

- Be able to apply analytical, numerical and/or experimental methods for analysis and solving of advanced tasks within the field of specialization.
- Be able to apply relevant theory to field specific applications.
- Be able to solve advanced engineering tasks within the field of specialization.
- Be able to compare and evaluate assumptions, limitations and uncertainties related to the methods applied in connection to finding solutions of advanced challenges within the field of specialization.
- Master the scientific methods and general skills related to the field of specialization.
- Compose a project report according to the field's norms, use correct professional language, document extensive inclusion of relevant original literature, communicate and discuss the project's research-based basis and problem and results in a written, graphic and oral manner in a coherent way.
- Critically evaluate the project's results in relation to relevant original literature and current scientific methods, models and evaluate and discuss the project's problem in a relevant technical scientific context.
- Assess and put the project's potential into perspective for further development.

COMPETENCES

- Be able to handle development-oriented situations in connection to either studying or working.
- Be able to analyse and solve an actual problem of industrial relevance through application of systematic research and development processes, including advanced analytical, experimental and/or numerical methods and models.
- Be able to use the correct terminology in oral, written or graphical communication and documentation of challenges and solutions within the field of specialization.
- Participate in and independently carry out technological development and research, as well as solve complex tasks using scientific methods.
- Perform planning, implementation and management of complex and unpredictable research and / or development tasks and assume a professional responsibility for completing independent academic tasks as well as interdisciplinary collaborations.
- Independently take responsibility for own professional development and specialization.

TYPE OF INSTRUCTION

The project work is carried out as an independent work process in which the students themselves organize and coordinate their workload in collaboration with a supervisor.

The project may be carried out individually or in groups.

EXTENT AND EXPECTED WORKLOAD

Since it is a 25 ECTS project module the expected workload is 750 hours for the student.

EXAM

EXAMS

Name of exam	Industrial Development
Type of exam	Oral exam based on a project
ECTS	25
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	Industrielt udviklingsarbejde
Module code	M-ME-K3-2A
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	25
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Torben Ole Andersen, Simon Bøgh, Sergey Sorokin

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

INDUSTRIAL DEVELOPMENT

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Hold knowledge of analytical, numerical and/or experimental methods for analysis of advanced tasks within the field of specialization.
- Understand the connection between engineering and scientific theory and their application in practical problems.
- Explain the scientific basis and scientific issues within the specialization.
- Explain the highest international research in the field of specialization.

SKILLS

- Be able to apply analytical, numerical and/or experimental methods for analysis and solving of advanced tasks within the field of specialization.
- Be able to apply relevant theory to field specific applications.
- Be able to solve advanced engineering tasks within the field of specialization.
- Be able to compare and evaluate assumptions, limitations and uncertainties related to the methods applied in connection to finding solutions of advanced challenges within the field of specialization.
- Master the scientific methods and general skills related to the field of specialization.
- Compose a project report according to the field's norms, use correct professional language, document extensive inclusion of relevant original literature, communicate and discuss the project's research-based basis and problem and results in a written, graphic and oral manner in a coherent way.
- Critically evaluate the project's results in relation to relevant original literature and current scientific methods, models and evaluate and discuss the project's problem in a relevant technical scientific context.
- Assess and put the project's potential into perspective for further development.

COMPETENCES

- Be able to handle development-oriented situations in connection to either studying or working.
- Be able to analyse and solve an actual problem of industrial relevance through application of systematic research and development processes, including advanced analytical, experimental and/or numerical methods and models.
- Be able to use the correct terminology in oral, written or graphical communication and documentation of challenges and solutions within the field of specialization.
- Participate in and independently carry out technological development and research, as well as solve complex tasks using scientific methods.
- Perform planning, implementation and management of complex and unpredictable research and / or development tasks and assume a professional responsibility for completing independent academic tasks as well as interdisciplinary collaborations.
- Independently take responsibility for own professional development and specialization.

TYPE OF INSTRUCTION

The project work is carried out as an independent work process in which the students themselves organize and coordinate their workload in collaboration with a supervisor.

The project may be carried out individually or in groups.

EXTENT AND EXPECTED WORKLOAD

Since it is a 20 ECTS project module the expected workload is 600 hours for the student.

EXAM

EXAMS

Name of exam	Industrial Development
Type of exam	Oral exam based on a project
ECTS	20
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Industrielt udviklingsarbejde
Module code	M-ME-K3-5A
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	20
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Torben Ole Andersen, Simon Bøgh, Sergey Sorokin

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

INDUSTRIAL DEVELOPMENT

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Hold knowledge of analytical, numerical and/or experimental methods for analysis of advanced tasks within the field of specialization.
- Understand the connection between engineering and scientific theory and their application in practical problems.
- Explain the scientific basis and scientific issues within the specialization.
- Explain the highest international research in the field of specialization.

SKILLS

- Be able to apply analytical, numerical and/or experimental methods for analysis and solving of advanced tasks within the field of specialization.
- Be able to apply relevant theory to field specific applications.
- Be able to solve advanced engineering tasks within the field of specialization.
- Be able to compare and evaluate assumptions, limitations and uncertainties related to the methods applied in connection to finding solutions of advanced challenges within the field of specialization.
- Master the scientific methods and general skills related to the field of specialization.
- Compose a project report according to the field's norms, use correct professional language, document extensive inclusion of relevant original literature, communicate and discuss the project's research-based basis and problem and results in a written, graphic and oral manner in a coherent way.
- Critically evaluate the project's results in relation to relevant original literature and current scientific methods, models and evaluate and discuss the project's problem in a relevant technical scientific context.
- Assess and put the project's potential into perspective for further development.

COMPETENCES

- Be able to handle development-oriented situations in connection to either studying or working.
- Be able to analyse and solve an actual problem of industrial relevance through application of systematic research and development processes, including advanced analytical, experimental and/or numerical methods and models.
- Be able to use the correct terminology in oral, written or graphical communication and documentation of challenges and solutions within the field of specialization.
- Participate in and independently carry out technological development and research, as well as solve complex tasks using scientific methods.
- Perform planning, implementation and management of complex and unpredictable research and / or development tasks and assume a professional responsibility for completing independent academic tasks as well as interdisciplinary collaborations.
- Independently take responsibility for own professional development and specialization.

TYPE OF INSTRUCTION

The project work is carried out as an independent work process in which the students themselves organize and coordinate their workload in collaboration with a supervisor.

The project may be carried out individually or in groups.

EXTENT AND EXPECTED WORKLOAD

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

EXAM

EXAMS

Name of exam	Industrial Development
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	Industrielt udviklingsarbejde
Module code	M-ME-K3-6A
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	Torben Ole Andersen, Simon Bøgh, Sergey Sorokin

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

PROJECT-ORIENTED STUDY IN AN EXTERNAL ORGANISATION

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

The Project-Oriented Study in an External Organisation must have a scope that corresponds to the ECTS load.

LEARNING OBJECTIVES

KNOWLEDGE

- Hold knowledge of analytical, numerical and/or experimental methods for analysis of advanced tasks within the field of specialization.
- Understand the connection between engineering and scientific theory and their application in practical problems.
- Explain the scientific basis and scientific issues within the specialization.
- Explain the highest international research in the field of specialization.

SKILLS

- Be able to apply analytical, numerical and/or experimental methods for analysis and solving of advanced tasks within the field of specialization.
- Be able to apply relevant theory to field specific applications.
- Be able to solve advanced engineering tasks within the field of specialization.
- Be able to compare and evaluate assumptions, limitations and uncertainties related to the methods applied in connection to finding solutions of advanced challenges within the field of specialization.
- Master the scientific methods and general skills related to the field of specialization.
- Compose a project report according to the field's norms, use correct professional language, document extensive inclusion of relevant original literature, communicate and discuss the project's research-based basis and problem and results in a written, graphic and oral manner in a coherent way.
- Critically evaluate the project's results in relation to relevant original literature and current scientific methods, models and evaluate and discuss the project's problem in a relevant technical scientific context.
- Assess and put the project's potential into perspective for further development.

COMPETENCES

- Be able to handle development-oriented situations in connection to either studying or working.
- Be able to analyse and solve an actual problem of industrial relevance through application of systematic research and development processes, including advanced analytical, experimental and/or numerical methods and models.
- Be able to use the correct terminology in oral, written or graphical communication and documentation of challenges and solutions within the field of specialization.
- Participate in and independently carry out technological development and research, as well as solve complex tasks using scientific methods.
- Perform planning, implementation and management of complex and unpredictable research and / or development tasks and assume a professional responsibility for completing independent academic tasks as well as interdisciplinary collaborations.
- Independently take responsibility for own professional development and specialization.

TYPE OF INSTRUCTION

The project work is carried out as an independent work process in which the students themselves organize and coordinate their workload in collaboration with a supervisor.

When doing a project-oriented stay in a company, the student is included in the company’s daily work and carry out independent project work on an industrial problem relevant for the company. Concurrent to the work in the company, the student makes a project report, which is evaluated after the ending of the internship. A project-oriented stay in a company has to be approved by the study board.

EXTENT AND EXPECTED WORKLOAD

Since it is a 25 ECTS project module the expected workload is 750 hours for the student.

EXAM

EXAMS

Name of exam	Project-oriented Study in an External Organisation
Type of exam	Oral exam based on a project
ECTS	30
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Projektorienteret forløb i en virksomhed
Module code	M-ME-K3-4A
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	30
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Sergey Sorokin, Simon Bøgh, Torben Ole Andersen

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

PROJECT ORIENTED STUDY IN AN EXTERNAL ORGANISATION

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

The Project-Oriented Study in an External Organisation must have a scope that corresponds to the ECTS load.

LEARNING OBJECTIVES

KNOWLEDGE

- Hold knowledge of analytical, numerical and/or experimental methods for analysis of advanced tasks within the field of specialization.
- Understand the connection between engineering and scientific theory and their application in practical problems.
- Explain the scientific basis and scientific issues within the specialization.
- Explain the highest international research in the field of specialization.

SKILLS

- Be able to apply analytical, numerical and/or experimental methods for analysis and solving of advanced tasks within the field of specialization.
- Be able to apply relevant theory to field specific applications.
- Be able to solve advanced engineering tasks within the field of specialization.
- Be able to compare and evaluate assumptions, limitations and uncertainties related to the methods applied in connection to finding solutions of advanced challenges within the field of specialization.
- Master the scientific methods and general skills related to the field of specialization.
- Compose a project report according to the field's norms, use correct professional language, document extensive inclusion of relevant original literature, communicate and discuss the project's research-based basis and problem and results in a written, graphic and oral manner in a coherent way.
- Critically evaluate the project's results in relation to relevant original literature and current scientific methods, models and evaluate and discuss the project's problem in a relevant technical scientific context.
- Assess and put the project's potential into perspective for further development.

COMPETENCES

- Be able to handle development-oriented situations in connection to either studying or working.
- Be able to analyse and solve an actual problem of industrial relevance through application of systematic research and development processes, including advanced analytical, experimental and/or numerical methods and models.
- Be able to use the correct terminology in oral, written or graphical communication and documentation of challenges and solutions within the field of specialization.
- Participate in and independently carry out technological development and research, as well as solve complex tasks using scientific methods.
- Perform planning, implementation and management of complex and unpredictable research and / or development tasks and assume a professional responsibility for completing independent academic tasks as well as interdisciplinary collaborations.
- Independently take responsibility for own professional development and specialization.

TYPE OF INSTRUCTION

The project work is carried out as an independent work process in which the students themselves organize and coordinate their workload in collaboration with a supervisor.

When doing a project-oriented stay in a company, the student is included in the company’s daily work and carry out independent project work on an industrial problem relevant for the company. Concurrent to the work in the company, the student makes a project report, which is evaluated after the ending of the internship. A project-oriented stay in a company has to be approved by the study board.

EXTENT AND EXPECTED WORKLOAD

Since it is a 25 ECTS project module the expected workload is 750 hours for the student.

EXAM

EXAMS

Name of exam	Project Oriented Study in an External Organisation
Type of exam	Oral exam based on a project
ECTS	25
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Projektorienteret forløb i en virksomhed
Module code	M-ME-K3-3A
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	25
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Sergey Sorokin, Simon Bøgh, Torben Ole Andersen

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

PROJECT ORIENTED STUDY IN AN EXTERNAL ORGANISATION

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

The Project-Oriented Study in an External Organisation must have a scope that corresponds to the ECTS load.

LEARNING OBJECTIVES

KNOWLEDGE

- Hold knowledge of analytical, numerical and/or experimental methods for analysis of advanced tasks within the field of specialization.
- Understand the connection between engineering and scientific theory and their application in practical problems.
- Explain the scientific basis and scientific issues within the specialization.
- Explain the highest international research in the field of specialization.

SKILLS

- Be able to apply analytical, numerical and/or experimental methods for analysis and solving of advanced tasks within the field of specialization.
- Be able to apply relevant theory to field specific applications.
- Be able to solve advanced engineering tasks within the field of specialization.
- Be able to compare and evaluate assumptions, limitations and uncertainties related to the methods applied in connection to finding solutions of advanced challenges within the field of specialization.
- Master the scientific methods and general skills related to the field of specialization.
- Compose a project report according to the field's norms, use correct professional language, document extensive inclusion of relevant original literature, communicate and discuss the project's research-based basis and problem and results in a written, graphic and oral manner in a coherent way.
- Critically evaluate the project's results in relation to relevant original literature and current scientific methods, models and evaluate and discuss the project's problem in a relevant technical scientific context.
- Assess and put the project's potential into perspective for further development.

COMPETENCES

- Be able to handle development-oriented situations in connection to either studying or working.
- Be able to analyse and solve an actual problem of industrial relevance through application of systematic research and development processes, including advanced analytical, experimental and/or numerical methods and models.
- Be able to use the correct terminology in oral, written or graphical communication and documentation of challenges and solutions within the field of specialization.
- Participate in and independently carry out technological development and research, as well as solve complex tasks using scientific methods.
- Perform planning, implementation and management of complex and unpredictable research and / or development tasks and assume a professional responsibility for completing independent academic tasks as well as interdisciplinary collaborations.
- Independently take responsibility for own professional development and specialization.

TYPE OF INSTRUCTION

The project work is carried out as an independent work process in which the students themselves organize and coordinate their workload in collaboration with a supervisor.

When doing a project-oriented stay in a company, the student is included in the company’s daily work and carry out independent project work on an industrial problem relevant for the company. Concurrent to the work in the company, the student makes a project report, which is evaluated after the ending of the internship. A project-oriented stay in a company has to be approved by the study board.

EXTENT AND EXPECTED WORKLOAD

Since it is a 20 ECTS project module the expected workload is 600 hours for the student.

EXAM

EXAMS

Name of exam	Project Oriented Study in an External Organisation
Type of exam	Oral exam based on a project
ECTS	20
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Projektorienteret forløb i en virksomhed
Module code	M-ME-K3-7A
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	20
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Sergey Sorokin, Simon Bøgh, Torben Ole Andersen

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

PROJECT ORIENTED STUDY IN AN EXTERNAL ORGANISATION

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

The Project-Oriented Study in an External Organisation must have a scope that corresponds to the ECTS load.

LEARNING OBJECTIVES

KNOWLEDGE

- Hold knowledge of analytical, numerical and/or experimental methods for analysis of advanced tasks within the field of specialization.
- Understand the connection between engineering and scientific theory and their application in practical problems.
- Explain the scientific basis and scientific issues within the specialization.
- Explain the highest international research in the field of specialization.

SKILLS

- Be able to apply analytical, numerical and/or experimental methods for analysis and solving of advanced tasks within the field of specialization.
- Be able to apply relevant theory to field specific applications.
- Be able to solve advanced engineering tasks within the field of specialization.
- Be able to compare and evaluate assumptions, limitations and uncertainties related to the methods applied in connection to finding solutions of advanced challenges within the field of specialization.
- Master the scientific methods and general skills related to the field of specialization.
- Compose a project report according to the field's norms, use correct professional language, document extensive inclusion of relevant original literature, communicate and discuss the project's research-based basis and problem and results in a written, graphic and oral manner in a coherent way.
- Critically evaluate the project's results in relation to relevant original literature and current scientific methods, models and evaluate and discuss the project's problem in a relevant technical scientific context.
- Assess and put the project's potential into perspective for further development.

COMPETENCES

- Be able to handle development-oriented situations in connection to either studying or working.
- Be able to analyse and solve an actual problem of industrial relevance through application of systematic research and development processes, including advanced analytical, experimental and/or numerical methods and models.
- Be able to use the correct terminology in oral, written or graphical communication and documentation of challenges and solutions within the field of specialization.
- Participate in and independently carry out technological development and research, as well as solve complex tasks using scientific methods.
- Perform planning, implementation and management of complex and unpredictable research and / or development tasks and assume a professional responsibility for completing independent academic tasks as well as interdisciplinary collaborations.
- Independently take responsibility for own professional development and specialization.

TYPE OF INSTRUCTION

The project work is carried out as an independent work process in which the students themselves organize and coordinate their workload in collaboration with a supervisor.

When doing a project-oriented stay in a company, the student is included in the company’s daily work and carry out independent project work on an industrial problem relevant for the company. Concurrent to the work in the company, the student makes a project report, which is evaluated after the ending of the internship. A project-oriented stay in a company has to be approved by the study board.

EXTENT AND EXPECTED WORKLOAD

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

EXAM

EXAMS

Name of exam	Project Oriented Study in an External Organisation
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	Projektorienteret forløb i en virksomhed
Module code	M-ME-K3-8A
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	Sergey Sorokin, Simon Bøgh, Torben Ole Andersen

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

MASTER'S THESIS

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have attained thorough understanding of a broad range of theoretical, numerical and experimental techniques within the area of specialization.
- Thorough knowledge of relevant theory, methodology, key elements and their mutual contextual relations within the area of specialization.
- Explain the scientific basis and scientific issues within the specialization.
- Explain the highest international research in the field of specialization.

SKILLS

- Be able to apply scientific methodology to solve a wide variety of problems within the field of specialization.
- Be able to perform scientific work in relevant topics within the field of specialization.
- Be able to apply a wide range of engineering methods in research and development projects in the field of specialization.
- Be able to participate or lead projects in mechanical system design, product development, modelling and analysis within the field of specialization.
- Master the scientific methods and general skills related to the field of specialization.
- Compose a project report according to the field's norms, use correct professional language, document extensive inclusion of relevant original literature, communicate and discuss the project's research-based basis and problem and results in a written, graphic and oral manner in a coherent way.
- Critically evaluate the project's results in relation to relevant original literature and current scientific methods, models and evaluate and discuss the project's problem in a relevant technical scientific context.
- Assess and put the project's potential into perspective for further development.

COMPETENCES

- Identifying, formulating and analysing industrially relevant problems using independent, systematic and critical thinking.
- Relating a problem to the scientific area in question and justify the choices made with regards to the problem definition in a relevant way.
- Be able to work independently with a project on a specific problem within their field of interest on the highest possible level within their specialization.
- Be able to take part in technical research and development.
- Be able to direct the technical management of development projects within the industry.
- Be competent to solve new and complicated technical problems by the use of advanced mathematics, scientific and technological knowledge.
- Participate in and independently carry out technological development and research, as well as solve complex tasks using scientific methods.
- Perform planning, implementation and management of complex and unpredictable research and / or development tasks and assume a professional responsibility for completing independent academic tasks as well as interdisciplinary collaborations.
- Independently take responsibility for own professional development and specialization.

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

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

A long Master's thesis of more than 30 ECTS must include work of experimental nature and has to be approved by the Head of Studies. The amount of experimental work must reflect the allotted ECTS.

EXAM

EXAMS

Name of exam	Master's Thesis
Type of exam	Master's thesis/final project
ECTS	45
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Kandidatspeciale
Module code	M-ME-K4-1B
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	45
Language of instruction	English
Location of the lecture	Campus Aalborg
Responsible for the module	Torben Ole Andersen, Sergey Sorokin, Simon Bøgh

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

MASTER'S THESIS

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have attained thorough understanding of a broad range of theoretical, numerical and experimental techniques within the area of specialization.
- Thorough knowledge of relevant theory, methodology, key elements and their mutual contextual relations within the area of specialization.
- Explain the scientific basis and scientific issues within the specialization.
- Explain the highest international research in the field of specialization.

SKILLS

- Be able to apply scientific methodology to solve a wide variety of problems within the field of specialization.
- Be able to perform scientific work in relevant topics within the field of specialization.
- Be able to apply a wide range of engineering methods in research and development projects in the field of specialization.
- Be able to participate or lead projects in mechanical system design, product development, modelling and analysis within the field of specialization.
- Master the scientific methods and general skills related to the field of specialization.
- Compose a project report according to the field's norms, use correct professional language, document extensive inclusion of relevant original literature, communicate and discuss the project's research-based basis and problem and results in a written, graphic and oral manner in a coherent way.
- Critically evaluate the project's results in relation to relevant original literature and current scientific methods, models and evaluate and discuss the project's problem in a relevant technical scientific context.
- Assess and put the project's potential into perspective for further development.

COMPETENCES

- Identifying, formulating and analysing industrially relevant problems using independent, systematic and critical thinking.
- Relating a problem to the scientific area in question and justify the choices made with regards to the problem definition in a relevant way.
- Be able to work independently with a project on a specific problem within their field of interest on the highest possible level within their specialization.
- Be able to take part in technical research and development.
- Be able to direct the technical management of development projects within the industry.
- Be competent to solve new and complicated technical problems by the use of advanced mathematics, scientific and technological knowledge.
- Participate in and independently carry out technological development and research, as well as solve complex tasks using scientific methods.
- Perform planning, implementation and management of complex and unpredictable research and / or development tasks and assume a professional responsibility for completing independent academic tasks as well as interdisciplinary collaborations.
- Independently take responsibility for own professional development and specialization.

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXAM

EXAMS

Name of exam	Master's Thesis
Type of exam	Master's thesis/final project
ECTS	50
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Kandidatspeciale
Module code	M-ME-K4-1C
Module type	Project
Duration	2 semesters
Semester	Spring
ECTS	50
Language of instruction	English
Location of the lecture	Campus Aalborg
Responsible for the module	Torben Ole Andersen, Sergey Sorokin, Simon Bøgh

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

MASTER'S THESIS

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have attained thorough understanding of a broad range of theoretical, numerical and experimental techniques within the area of specialization.
- Thorough knowledge of relevant theory, methodology, key elements and their mutual contextual relations within the area of specialization.
- Explain the scientific basis and scientific issues within the specialization.
- Explain the highest international research in the field of specialization.

SKILLS

- Be able to apply scientific methodology to solve a wide variety of problems within the field of specialization.
- Be able to perform scientific work in relevant topics within the field of specialization.
- Be able to apply a wide range of engineering methods in research and development projects in the field of specialization.
- Be able to participate or lead projects in mechanical system design, product development, modelling and analysis within the field of specialization.
- Master the scientific methods and general skills related to the field of specialization.
- Compose a project report according to the field's norms, use correct professional language, document extensive inclusion of relevant original literature, communicate and discuss the project's research-based basis and problem and results in a written, graphic and oral manner in a coherent way.
- Critically evaluate the project's results in relation to relevant original literature and current scientific methods, models and evaluate and discuss the project's problem in a relevant technical scientific context.
- Assess and put the project's potential into perspective for further development.

COMPETENCES

- Identifying, formulating and analysing industrially relevant problems using independent, systematic and critical thinking.
- Relating a problem to the scientific area in question and justify the choices made with regards to the problem definition in a relevant way.
- Be able to work independently with a project on a specific problem within their field of interest on the highest possible level within their specialization.
- Be able to take part in technical research and development.
- Be able to direct the technical management of development projects within the industry.
- Be competent to solve new and complicated technical problems by the use of advanced mathematics, scientific and technological knowledge.
- Participate in and independently carry out technological development and research, as well as solve complex tasks using scientific methods.
- Perform planning, implementation and management of complex and unpredictable research and / or development tasks and assume a professional responsibility for completing independent academic tasks as well as interdisciplinary collaborations.
- Independently take responsibility for own professional development and specialization.

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

Since it is a 60 ECTS project module we expect the workload is 1800 hours.

EXAM

EXAMS

Name of exam	Master's Thesis
Type of exam	Master's thesis/final project
ECTS	60
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Kandidatspeciale
Module code	M-ME-K4-1D
Module type	Project
Duration	2 semesters
Semester	Autumn
ECTS	60
Language of instruction	English
Location of the lecture	Campus Aalborg
Responsible for the module	Torben Ole Andersen, Sergey Sorokin, Simon Bøgh

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

MASTER'S THESIS

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have attained thorough understanding of a broad range of theoretical, numerical and experimental techniques within the area of specialization.
- Thorough knowledge of relevant theory, methodology, key elements and their mutual contextual relations within the area of specialization.
- Explain the scientific basis and scientific issues within the specialization.
- Explain the highest international research in the field of specialization.

SKILLS

- Be able to apply scientific methodology to solve a wide variety of problems within the field of specialization.
- Be able to perform scientific work in relevant topics within the field of specialization.
- Be able to apply a wide range of engineering methods in research and development projects in the field of specialization.
- Be able to participate or lead projects in mechanical system design, product development, modelling and analysis within the field of specialization.
- Master the scientific methods and general skills related to the field of specialization.
- Compose a project report according to the field's norms, use correct professional language, document extensive inclusion of relevant original literature, communicate and discuss the project's research-based basis and problem and results in a written, graphic and oral manner in a coherent way.
- Critically evaluate the project's results in relation to relevant original literature and current scientific methods, models and evaluate and discuss the project's problem in a relevant technical scientific context.
- Assess and put the project's potential into perspective for further development.

COMPETENCES

- Identifying, formulating and analysing industrially relevant problems using independent, systematic and critical thinking.
- Relating a problem to the scientific area in question and justify the choices made with regards to the problem definition in a relevant way.
- Be able to work independently with a project on a specific problem within their field of interest on the highest possible level within their specialization.
- Be able to take part in technical research and development.
- Be able to direct the technical management of development projects within the industry.
- Be competent to solve new and complicated technical problems by the use of advanced mathematics, scientific and technological knowledge.
- Participate in and independently carry out technological development and research, as well as solve complex tasks using scientific methods.
- Perform planning, implementation and management of complex and unpredictable research and / or development tasks and assume a professional responsibility for completing independent academic tasks as well as interdisciplinary collaborations.
- Independently take responsibility for own professional development and specialization.

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

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

EXAM

EXAMS

Name of exam	Master's Thesis
Type of exam	Master's thesis/final project
ECTS	30
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Kandidatspeciale
Module code	M-ME-K4-1A
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	30
Language of instruction	English
Location of the lecture	Campus Aalborg
Responsible for the module	Torben Ole Andersen, Sergey Sorokin, Simon Bøgh

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

CONTROL OF FLUID POWER AND ELECTRICAL SERVOMECHANISMS

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have gained an understanding of analysis, design and control of hydraulic servo mechanisms
- Have gained knowledge about methods for electro-mechanical energy conversion by means DC and square-wave brushless machines
- Have gained knowledge about the construction, the operating principles, the modelling and the performance characteristics for DC and brushless machines
- Have a basic understanding about closed-loop control principles for DC and brushless machines for servo applications
- Have a fundamental understanding of permanent magnet materials and their applications in electric actuators
- Have gained knowledge about methods for electric energy conversion by power electronic converters
- Have gained knowledge about active and passive power electronic components and their use in power converters.
- Have gained an understanding of Lagrange equation and how it is used for modelling of a mechanical system.
- Have a basic understanding of non-linarites in mechanical system including modal interaction.

SKILLS

- Be able to set up the governing equations (physically based) for a hydraulic servo system
- Be able to apply linear control strategies to a hydraulic servo system
- Be able to analyse different kinds of DC machines and to formulate dynamic models hereof
- Be able to calculate performance characteristics for the DC machine and to select a DC motor for a given application
- Be able to analyse and to design servo systems using DC machines with speed, position and current feedback
- Understand the basics of square-wave permanent magnet brushless machines and their applications for servo mechanisms
- Be able to understand the operating principles for basic electric converters, including pulse-width modulated buck, boost, half- and full-bridge converters
- Understand the fundamentals of semiconductor physics and the basic operating principles for power semiconductor devices such as power diodes and MOSFET’s
- Be able to read power semiconductors datasheets, including understanding of switching characteristics and safe operating areas
- Be able to design simple power electronic converters, including gate drivers and thermal aspects such as switching and conduction losses
- Have a basic understanding of good circuit layout techniques for switching converters.
- Be able to set up a dynamic model for mechanical system using Lagrange equation.

COMPETENCES

- Have the ability to model and analyse a hydraulic servo system, thereby being able to set up performance criteria and identify performance limitations
- Be able to design and implement linear controllers for hydraulic servo mechanisms and evaluate and validate the performance obtained
- Have the ability to design, model and simulate a servo system based on either a DC machine or a square-wave brushless machine
- Be able to design a closed-loop servo control system taking component limitations into account and to use a power electronic converter as part of the actuator system
- Be able to design simple power electronic converters, including component selection and proper thermal management.

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module the expected workload is 150 hours for the student.

EXAM

EXAMS

Name of exam	Control of Fluid Power and Electrical Servomechanisms
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	Regulering af hydrauliske og elektriske servomekanismer
Module code	M-EMS-K1-2
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	Sergiu Viorel Spataru, Peter Omand Rasmussen, Anders Hedegaard Hansen

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

EMBEDDED MICRO PROCESSORS: APPLICATIONS AND C PROGRAMMING

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have gained a fundamental knowledge about *C*/*C*++ programming and have a basic understanding of structured object-oriented programming
- Have attained a basic understanding of the architecture and the applications of micro processors, including digital signal processors (DSP) and micro controller units (MCU)
- Have gained experience with programming of DSP's and MCU's for real-time applications, including interfacing to peripheral units

SKILLS

- Be able to understand basic *C* syntax, including *C* data types, statements, loop constructs and functions
- Be able to understand basic object-oriented programming concepts, including classes, objects, scope, constructors, destructors and inheritance
- Be able to use pointers, arrays and function pointers in C
- Be able to use static and dynamic memory allocation
- Be able to understand the interrupt concept and its use for real-time task scheduling and prioritisation
- Be able to understand basic architectures used in micro processor systems
- Be able to understand and to configure a micro processor's built-in peripheral units
- Be able to understand the role and application of peripheral serial interfaces such as e.g. SPI and I2C
- Be familiar with *C*/*C*++ development tool chains and the use of integrated development environments

COMPETENCES

- Have the ability to develop and to test algorithms in *C* and *C*++ for real-time micro processor applications
- Be able to use peripheral units such as e.g. A/D converters, timers, pulse-width modulator units, encoder interface for interfacing an DSP/MCU to external devices such as sensors and actuators
- Be able to implement control and monitoring algorithms taking timing and prioritisation aspects into account
- Be able to apply serial interfaces for communication with external devices such as e.g. D/A converters and intelligent sensors

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module the expected workload is 150 hours for the student.

EXAM

EXAMS

Name of exam	Embedded Micro Processors: Applications and C Programming
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	Indlejrede mikroprocessorer: anvendelse og C programmering
Module code	M-EMS-K1-3
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Lajos Török, Sergiu Viorel Spataru

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

MULTI VARIABLE CONTROL

2021/2022

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module is based on knowledge achieved in classical control theory and state space control.

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have gained an in-depth understanding of basic aspects of multivariable control design, the approaches, the key quantities to consider and the fundamental limitations inherent in the design
- Be able to, on a scientific basis, to understand and apply advanced model based control design tools
- Be able to document understanding of multivariable systems (multiple inputs and multiple outputs MIMO)

SKILLS

- Be able to understand the fundamental performance limitations of single input and single output (SISO) systems
- Be able to represent linear systems in different ways: Transfer functions matrices, input-output equations, state space form, etc.
- Be able to understand what disturbances are, and to describe their character in a suitable way
- Be able to set up design specifications for MIMO systems
- Be able to understand basic limitations in control design
- Be able to set up the configuration of multivariable controllers
- Be able to design linear multivariable controllers

COMPETENCES

- Be able to undertake analysis, design and implementation of advanced multivariable control systems where experience and intuition play a very important role

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module the expected workload is 150 hours for the student.

EXAM

EXAMS

Name of exam	Multi Variable Control
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	Multivariabel regulering
Module code	M-EMS-K2-3
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	Lasse Schmidt

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

AC MOTOR DRIVES: CONVERTERS AND CONTROL

2021/2022

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

This module is based on knowledge gained on 1st Semester of the MSc programme in Electro-Mechanical System Design.

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have gained knowledge of methods for electro-mechanical energy conversion by means of three-phase AC machines
- Have gained knowledge of the construction and the operating principles for induction machines and for three-phase sine-wave brushless machines
- Understand the stationary performance characteristics for such machines
- Have a solid understanding of stationary and dynamic models of AC machines
- Have gained a solid understanding of basic methods for speed control of AC machines using power electronic converters
- Have gained a basic understanding of high-performance torque control methods based on vector-control principles
- Have gained knowledge of power electronic converters for AC drives
- Have knowledge of dynamic models of power converters
- Understand the principle of three-phase pulse-width modulation (PWM) for three-phase systems and being able to apply PWM as part of an AC motor control loop

SKILLS

- Be able to explain the operating principles for induction and brushless machines
- Be able to apply equivalent circuit diagrams for stationary performance analysis
- Be able to measure motor parameters using standard tests
- Be able to make dynamic models of AC machines using space-vector models in stationary and rotating coordinates
- Be able to design and to simulate simple scalar control techniques for AC machines based on stationary performance characteristics
- Be able to understand field-oriented control techniques and to apply these for high-performance AC drives
- Be able to design a pulse-width modulator using both carrier-based and space-vector based approaches
- Being able to analyse and to model single- and three-phase power converters taking component voltage drops and blanking effects into account

COMPETENCES

- Have the ability to analyse, model and simulate the stationary and dynamic characteristics for an AC motor drive based on both induction and permanent-magnet machines
- Be able to design a complete AC motor control system using either classical V/Hz techniques or high-performance vector-control techniques based on field-orientation and instantaneous current control

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module the expected workload is 150 hours for the student.

EXAM

EXAMS

Name of exam	AC Motor Drives: Converters and Control
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	AC motor drev: konvertere og regulering
Module code	M-EMS-K2-4
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	Peter Omand Rasmussen

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

TECHNOLOGY AND OPERATIONS MANAGEMENT

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Understand the fundamental principles of operations management in setups where technology is seen as an essential driver
- Have an understanding of the relationship between technology maturity and operations management
- Understand the use of comprehensive manufacturing concepts that include both mechanical and IT based elements
- Understand the assumptions and limitations of the modelling and simulation tools in the process of planning and implementing

SKILLS

- Be able to develop a requirements specification for a manufacturing system with a high degree of technological uncertainty
- Be able to develop solution concepts that include both mechanical and IT based elements
- Be able to identify critical elements of proposed solution concepts.
- Be able to use appropriate modelling and simulation tools for developing solutions
- Be able to formulate a plan for a project's implementation

COMPETENCES

- Be able to professionally participate in the development of new manufacturing systems, focusing on the evaluation, selection and implementation of relevant technologies
- Establish the foundation for applying advanced and relevant simulation tools for future research and development activities.

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module the expected workload is 150 hours for the student.

EXAM

EXAMS

Name of exam	Technology and Operations Management
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	Teknologi- og driftsledelse
Module code	M-MT-K1-3
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Poul Kyvsgaard Hansen

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

DESIGN FOR MANUFACTURING

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have gained an in-depth understanding of:
  - Concepts, theories and methods regarding models for disposition of specific product design features according to needs and wants from other organizational functional areas
  - Technologies and systems that can support the development of such dispositions.
- Have gained knowledge about the relationships between the knowledge elements in regards product design features and their impact on other organizational areas. Among these are financial aspects.

SKILLS

- Be able to use of the theories and methods in design of specific DFM systems
- Be able to use relevant technologies and systems in solving specific product design problems in practice
- Be able to evaluate theoretic and practical needs for DFM and to select and substantiate economical attractive solutions
- Be able to communicate such problems and solution models to other participants in development projects.

COMPETENCES

- Be able to apply knowledge and skills in relation to complex development projects
- Be able to contribute constructively and professionally in multidisciplinary projects
- Be able to identify personal needs for additional learning and an appropriate approach

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module the expected workload is 150 hours for the student.

EXAM

EXAMS

Name of exam	Design for Manufacturing
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	Udvikling med produktionshensyn
Module code	M-MT-K1-4
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	Karl Brian Nielsen

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

PRODUCT DEVELOPMENT AND MODELLING

2021/2022

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

This module is based on knowledge gained on the 1st Semester of the MSc in the Manufacturing Technology programme.

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have an understanding of the fundamental principles of product design and development
- Have an understanding of the relationship between product design and manufacturing (design for manufacturing)
- Have an understanding of product modelling and product configuration and its implications for manufacturing

SKILLS

- Be able to use basic system theory, methods, models and approaches, including the domain theory for design of manufacturing systems
- Be able to use product modelling in support of design and as a means of integration
- Be able to use various design for X methods
- Be able to use systematic methods for specification and development of product modules and platforms

COMPETENCES

- Have the ability to systematically develop new products, in particular new manufacturing systems
- Have improved the ability to interact with product designers, enabling design for manufacturing

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module the expected workload is 150 hours for the student.

EXAM

EXAMS

Name of exam	Product Development and Modelling
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	Produktudvikling og -modellering
Module code	M-MT-K2-4
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	Ole Madsen

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

MACHINE LEARNING

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

The course gives a comprehensive introduction to machine learning, which is a field concerned with learning from examples and has roots in computer science, statistics and pattern recognition. The objective is realized by presenting methods and tools proven valuable and by addressing specific application problems.

LEARNING OBJECTIVES

KNOWLEDGE

- Must have knowledge about supervised learning methods including K-nearest neighbors, decision trees, linear discriminant analysis, support vector machines, and neural networks.
- Must have knowledge about unsupervised learning methods including K-means, Gaussian mixture model, hidden Markov model, EM algorithm, and principal component analysis.
- Must have knowledge about probabilistic graphical models, variational Bayesian methods, belief propagation, and mean-field approximation.
- Must have knowledge about Bayesian decision theory, bias and variance trade-off, and cross-validation.
- Must be able to understand reinforcement learning.

SKILLS

- Must be able to apply the taught methods to solve concrete engineering problems.
- Must be able to evaluate and compare the methods within a specific application problem.

COMPETENCES

- Must have competencies in analyzing a given problem and identifying appropriate machine learning methods to the problem.
- Must have competencies in understanding the strengths and weaknesses of the methods.

TYPE OF INSTRUCTION

As described in § 17.

EXAM

EXAMS

Name of exam	Machine Learning
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	Maskinlæring

Module code	ESNSPAK3K2F
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

ROBOT VISION

2021/2022

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

This module is based on knowledge gained on the 1st Semester of the MSc in the Manufacturing Technology programme.

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have gained an understanding of relevant technologies enabling the design of adaptive production machines
- Have gained an understanding of machine vision and how this is integrated into robotic solutions
- Have gained an understanding of how to simulate advanced robotic solutions
- Have knowledge about the business potential of robotic vision solutions.

SKILLS

- Be able to integrate various technologies to provide manufacturing systems with intelligent capabilities (e.g. reasoning, planning, communication, perception and the ability to move and manipulate objects)
- Be able to integrate and implement machine vision into a small and limited manufacturing system.
- Be able to simulate robotic solutions.

COMPETENCES

- Be able to professionally participate in projects aiming at developing advanced robotic cells.
- Establish the foundation for applying vision and relevant simulation tools for future research and development activities.

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module the expected workload is 150 hours for the student.

EXAM

EXAMS

Name of exam	Robot Vision
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 Vision
Module code	M-MT-K2-2
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	Dimitris Chrysostomou

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

DIGITAL MANUFACTURING

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have an understanding of how integrated computer-based systems can be used to develop product and manufacturing process definitions simultaneously.
- Have gained knowledge about systems and tools (e.g. modelling tools, simulation tools, 3D visualization tools, and collaboration tools) that can support this development.
- Have knowledge of how the digital information is created and distributed
- Have an in-depth understanding of the basic functionality of existing and emerging systems for digital manufacturing.
- Have an understanding of generic interfaces between systems for digital manufacturing.

SKILLS

- Be able to demonstrate a basic understanding of digital manufacturing.
- Be able to solve problems related to the simultaneous development of products and manufacturing.
- Be able to conduct a systematic assessment of the need for Digital Manufacturing.

COMPETENCES

- Use digital manufacturing tools to model, simulate and visualize issues related to the simultaneous development of products and manufacturing processes.
- Be able to judge the opportunities and limitations of Digital Manufacturing.

TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme cirruculum §17.

EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module the expected workload is 150 hours for the student.

EXAM

EXAMS

Name of exam	Digital Manufacturing
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	Digitalt understøttet fremstilling
Module code	M-MT-K2-5
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	Ole Madsen

ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	Faculty of Engineering and Science

COMPUTATIONAL FLUID DYNAMICS (CFD) AND MULTIPHASE FLOW

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have knowledge about the methods behind Computational Fluid Dynamics (CFD)
- Have knowledge about various spatial and temporal discretisation schemes
- Have knowledge about the pressure-velocity coupling method for solving the Navier-Stokes equations numerically
- Have knowledge about meshing strategies and boundary conditions
- Have knowledge about the fundamentals of turbulence, the energy cascade and Kolmogorov hypotheses
- Have knowledge and understanding within Reynolds-Averaged Navier-Stokes (RANS) and turbulence modelling
- Have knowledge about the fundamentals of multiphase flow
- Have knowledge about different modelling approaches for multiphase flow and multiphase models in the context of CFD
- Have knowledge about turbulence-particle interaction in multiphase flow

SKILLS

- Be able to use the finite volume method to numerically solve simple problems
- Be able to perform a mesh independency study in CFD analyses
- Be able to perform CFD analyses of a turbulent flow with regards to selection of turbulence model and near wall modelling/meshing strategy
- Be able to perform CFD analyses for non-reacting multiphase flow, for both the Euler-Euler and Euler-Lagrange approaches
- Be able to apply proper terminology in oral, written and graphical communication and documentation within CFD, turbulence and multiphase flows

COMPETENCES

- Be able to use the finite volume method to numerically solve simple problems
- Be able to perform a mesh independency study in CFD analyses
- Be able to perform CFD analyses of a turbulent flow with regards to selection of turbulence model and near wall modelling/meshing strategy
- Be able to perform CFD analyses for non-reacting multiphase flow, for both the Euler-Euler and Euler-Lagrange approaches
- Be able to apply proper terminology in oral, written and graphical communication and documentation within CFD, turbulence and multiphase flows

TYPE OF INSTRUCTION

Lectures supplemented by workshops, exercises, hands-on and self-studies.

EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module, the work load is expected to be 150 hours for the student.

EXAM

EXAMS

Name of exam	Computational Fluid Dynamics (CFD) and Multiphase Flow
Type of exam	Oral exam Oral examination which can be based on a mini-project.
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	Numerisk strømningslære (CFD) og flerfasestrømning
Module code	N-EE-K1-7
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg, Campus Esbjerg
Responsible for the module	Chungen Yin

ORGANISATION

Study Board	Study Board of Energy
Department	Department of Energy
Faculty	Faculty of Engineering and Science

SYSTEM IDENTIFICATION AND DIAGNOSIS

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have comprehension of the fundamental principles of typical methods of system identification
- Have comprehension of the fundamental concepts, terms and methodologies of abnormal diagnosis
- Have comprehension of some typical model-based and signal-based diagnosis

SKILLS

- Be able to apply the learned knowledge to handle some simple system identification problems under assistance of a commercial software
- Be able to apply and analyse different diagnosis methods

COMPETENCES

- Independently be able to define and analyse scientific problems within the area of system identification and diagnosis
- Independently be able to be a part of professional and interdisciplinary development work within the area of system identification and diagnosis

TYPE OF INSTRUCTION

The course is taught by a mixture of lectures, workshops, exercises, mini-projects and self-studies.

EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module, the work load is expected to be 150 hours for the student.

EXAM

EXAMS

Name of exam	System Identification and Diagnosis
Type of exam	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

ADDITIONAL INFORMATION

This course is taught to the 1st semester MSc students at the Offshore Energy Systems specialisation and is offered as an elective course at the 3rd semester of the Energy Engineering specialisations as well as the Process Engineering and Combustion Technology specialisation. Students of the Offshore Energy Systems specialisation cannot elect the module again.

FACTS ABOUT THE MODULE

Danish title	Systemidentifikation og diagnosticering
Module code	N-SEE-K1-3
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg, Campus Aalborg
Responsible for the module	Mohsen N. Soltani, Jesper Liniger

ORGANISATION

Study Board	Study Board of Energy
Department	Department of Energy
Faculty	Faculty of Engineering and Science

NON-LINEAR CONTROL AND MULTI-BODY SYSTEMS

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Be able to carry out kinematic analysis of multi-body systems
- Be able to model multi-body dynamical systems using selected methods
- Be able to develop complete system models that include actuators and possible hard non-linearities
- Be able to analyse systems using linearization-, Lyapunov- and phase plane methods
- Be able to design non-linear controllers for considered systems in the presence on uncertain and possibly varying system parameters

SKILLS

- Be able to establish various types models for non-linear system, including multi-body and actuator models
- Be able to judge the usefulness of the different analyses and design methods
- Be able to apply the learned knowledge to analyse and study non-linear dynamical systems
- Be able to design selected types of non-linear controllers
- Be able to implement selected types of non-linear controllers

COMPETENCES

- Independently be able to describe and analyse non-linear systems
- Independently be able to design considered non-linear controllers
- Independently be able to continue own development within the field of non-linear systems analysis and control

TYPE OF INSTRUCTION

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) - teacher feedback - professional reflection - portfolio work - laboratory Work The form(s) of teaching will be determined and described in connection with the planning of the semester. The description will account for the form(s) of teaching and may be accompanied by an elaboration of the roles of the participants.

EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module, the work load is expected to be 150 hours for the student.

EXAM

EXAMS

Name of exam	Non-linear Control and Multi-body 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

ADDITIONAL INFORMATION

This course is taught to the 1st semester MSc students at the Mechatronic Control Engineering specialisation and is offered as an elective course at the 3rd semester of all other specialisations. Students of the Mechatronic Control Engineering specialisation cannot elect the module again.

FACTS ABOUT THE MODULE

Danish title	Ikke-lineær regulering og flerlegeme systemer
Module code	N-EE-K1-11
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg, Campus Esbjerg
Responsible for the module	Lasse Schmidt

ORGANISATION

Study Board	Study Board of Energy
Department	Department of Energy
Faculty	Faculty of Engineering and Science

MODERN ELECTRICAL DRIVES

2021/2022

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module is based on knowledge achieved when studying the 2nd semester on the Master of Science in Energy Engineering with an electrical specialisation or Master of Science in Sustainable Energy Engineering with specialisation in Offshore Energy Systems or the Master in Advanced Power Electronics.

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have a solid knowledge about the electromagnetic field behaviour for various types of electrical machines. This gives a firm base for understanding of the advantages and disadvantages of different types of electrical machines. It consequently leads to a good understanding of new types of machines invented in recent years, e.g. the modern drive unit in electric vehicles or wind turbines, and magnetic gears.
- Have a detailed knowledge of the small DC link drive system and the corresponding active damping control methods. This has become a hot topic in recent years.
- Gain good experience about design of various controllers to meet different requirements, e.g. very low speed stable operation, low-cost controller design, drive stability issues, etc.

SKILLS

- Be able to understand and evaluate new types of high performance electrical machines that may occur in the future
- Be able to identify the pros and cons of existing sensorless control methods and design the most proper controller for selected applications
- Be aware of important practical implementation issues when designing the controller
- Be able to test, measure and characterize the performance of different electrical drive systems

COMPETENCES

- Independently be able to contribute to a professional team dealing with design of modern electrical drives, including new high performance electrical machines and advanced control technologies

TYPE OF INSTRUCTION

The course is taught by a mixture of lectures, workshops, exercises, mini-projects and self-studies. Instead of using complicated mathematical equations and electromagnetic theory, particularly-made Finite Element Models visualizing the electromagnetic field behaviour inside a machine will be used to give an easy but deep access to many difficult topics involved in the electrical machine theory. Various advanced sensorless control technologies developed in recent years will be discussed for permanent magnet machine and synchronous reluctance machine (which has received great interests in recent years). Achievements obtained from recent PhD projects carried out at the department will be presented.

EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module, the work load is expected to be 150 hours for the student.

EXAM

EXAMS

Name of exam	Modern Electrical Drives
Type of exam	Written and oral exam Oral examination based on a delivered mini-project/test report (individual or made in groups).
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Moderne elektriske drivsystemer
Module code	N-EE-K3-19
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg, Campus Esbjerg
Responsible for the module	Kaiyuan Lu

ORGANISATION

Study Board	Study Board of Energy
Department	Department of Energy
Faculty	Faculty of Engineering and Science