



AALBORG UNIVERSITET

# **STUDIEORDNING FOR BACHELORUDDANNELSEN I ANVENDT INDUSTRIEL ELEKTRONIK, 2022**

**BACHELOR (BSC) I TEKNISK VIDENSKAB  
ESBJERG**

**MODULER SOM INDGÅR I STUDIEORDNINGEN**

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# BASIC ELECTRONIC SYSTEMS

**2023/2024**

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

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

#### SKILLS

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

#### COMPETENCES

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

#### TYPE OF INSTRUCTION

Project work including supervision may be supplemented with lectures, workshops, presentation seminars, consultant meetings regarding PBL content, laboratory tests, etc. The project can be discipline oriented, interdisciplinary or be a part of a multi-disciplinary project dependent on project choice. The project work is split in two periods: P0 for problem definition and P1 for problem solving. The first period P0 lasts about 5-6 weeks. The work in the P0 period includes a problem analysis and a problem formulation for the subject to be dealt with in the P1 part of the project. This is written in a P0 document including also a process analysis for the P0 period. The P0 document is presented in a P0 status and presentation seminar as part of the course in Problem Based Learning, where the project group's documents are discussed.

Based on the problem analysis and problem formulation, the students then make a P1 project report where project goals are set up, analyses are performed and results are discussed. The project report should contain: Problem analysis, problem formulation, problem solution, analyses and results, as well as discussion and conclusion.

#### EXTENT AND EXPECTED WORKLOAD

Since it is a 15 ECTS project module, the work load is expected to be 450 hours for the student.

## EXAM

### PREREQUISITE FOR ENROLLMENT FOR THE EXAM

- It is a precondition for participation in the exam that the student has submitted a P0 report and has participated in the P0 status and presentation seminar.
- In case the student does not submit a P0 report or does not participate in the planned P0 status seminar, the student will have to present the P0 report to the supervisor no later than two weeks after the planned status seminar.

### EXAMS

Name of exam	Basic Electronic Systems
Type of exam	Oral exam based on a project Oral exam based on a project and process analysis.
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	Enkle elektroniske systemer
Module code	N-AIE-B1-1A
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	<a href="#">Dil Muhammad Akbar Hussain</a>

### ORGANISATION

Education owner	Bachelor of Science (BSc) in Engineering (Applied Industrial Electronics)
Study Board	Study Board of Build, Energy, Electronics and Mechanics in Esbjerg
Department	Department of Energy
Faculty	The Faculty of Engineering and Science

# CALCULUS

## 2023/2024

### CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

#### LEARNING OBJECTIVES

##### KNOWLEDGE

- Real functions of two and more variables – definitions, results and techniques concerning partial derivatives.
- Integration in plane and space wrt. various coordinate systems – including connections between such integrals.
- Complex numbers as an extension of the real numbers – in a geometric as well as an algebraic setup. The connection between the complex exponential function and trigonometric functions.
- The structure of the set of solutions to different types of first and second order differential equations.

##### SKILLS

- Differentiation of functions of several variables (including composite functions) as well as a geometric understanding of this.
- Extrema for functions of two and three variables.
- Maxima and minima for functions of two variables.
- Set up and evaluate simple integrals in plane and space wrt. various coordinate systems.
- Add, multiply and divide complex numbers. Transform between polar and Cartesian form.
- Solve and plot various types of first- and second order differential equations.

##### COMPETENCES

Can apply methods and concepts from calculus, including integration, complex numbers and differential equations to given problems relevant to the study programme.

##### TYPE OF INSTRUCTION

Lectures, exercises, videos, quiz, digitalised self-study, workshops on calculus problems relevant to the study programme.

##### EXTENT AND EXPECTED WORKLOAD

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

## EXAM

### EXAMS

Name of exam	Calculus
Type of exam	Written or oral exam
ECTS	5
Permitted aids	Please see the semester description / module description
Assessment	7-point grading scale

Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

## FACTS ABOUT THE MODULE

Danish title	Calculus
Module code	MATCAL1345GB
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	<a href="#">Morten Grud Rasmussen</a>

## ORGANISATION

Study Board	Study Board of Mathematical Sciences
Department	Department of Mathematical Sciences
Faculty	The Faculty of Engineering and Science

# ENERGISYSTEMERS GRUNDLÆGGENDE FYSIK OG OPBYGNING

2023/2024

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

### LÆRINGSMÅL

#### VIDEN

- Have viden om og forståelse for energibegreber
- Have viden om og forståelse for energisystemers opbygning
- Have viden om væsentlige energimaskiner som fx pumper, turbiner, varmevekslere, elmotorer og generatorer og deres funktion
- Have viden om enkle energitekniske beregninger
- Have opnået viden om statiske og kvasistatiske elektriske og magnetiske felter, kapacitet og induktans

#### FÆRDIGHEDER

- Kunne gennemføre grundlæggende energi- og effektmæssige beregninger
- Kunne opstille en model af et simpelt energisystem
- Kunne opstille simple formler for processerne i væsentlige energimaskiner
- Kunne gennemføre grundlæggende steady-state beregninger på energisystemer
- Kunne analysere statiske og kvasi statiske elektriske og magnetiske felter og deres udbredelse
- Kunne anvende elektrofysikken til bestemmelse af elektrisk modstand, kapacitans og induktans
- Kunne anvende elektrofysikken til beregning af mekaniske kræfter frembragt af elektriske og magnetiske felter
- Have færdigheder inden for elektrisk strøm, elektriske og magnetiske felter samt Ampères lov, Faradays lov, Lenz' lov samt Maxwells ligninger og ferromagnetiske materialer

#### KOMPETENCER

- Tilegne sig terminologien for fagområdet
- Kunne identificere egne læringsbehov og strukturere egen læring inden for energitekniske systemer og elektrofysik.

#### UNDERVISNINGSFORM

Forelæsninger, eventuelt suppleret med laboratorieøvelser og selvstudier inkluderende e-learning.

#### OMFANG OG FORVENTET ARBEJDSINDSAT

Kursusmodulets omfang er 5 ECTS svarende til 150 timers studieindsats.

#### EKSAMEN

#### PRØVER

Prøvens navn	Energisystemers grundlæggende fysik og opbygning
Prøveform	Mundtlig
ECTS	5
Bedømmelsesform	Bestået/ikke bestået
Censur	Intern prøve

Vurderingskriterier	Vurderingskriterierne er angivet i Universitetets eksamensordning
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## FAKTA OM MODULET

Engelsk titel	Fundamental Energy System Physics and Topology
Modulkode	N-EN-B1-4AZ
Modultype	Kursus
Varighed	1 semester
Semester	Efterår
ECTS	5
Undervisningssprog	Engelsk
Tomplads	Ja
Undervisningssted	Campus Aalborg, Campus Esbjerg
Modulansvarlig	<a href="#">Carsten Bojesen</a> , <a href="#">Esben Pilgaard Skovsen</a> , <a href="#">Tanmay Chaturvedi</a> , <a href="#">Amin Hajizadeh</a> , <a href="#">Jens Bo Holm-Nielsen</a>

## ORGANISATION

Studienævn	Studienævn for Byggeri, Energi, Elektronik og Maskin i Esbjerg
Institut	Institut for Energi
Fakultet	Det Ingeniør- og Naturvidenskabelige Fakultet



# PROBLEMBASERET LÆRING

2023/2024

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

### LÆRINGSMÅL

#### VIDEN

- centrale tilgange, begreber og teknikker i problembaseret læring
- forskellige problemtyper, projektyper og deres indbyrdes relationer
- videnskabsteoretiske positioner i problembaseret projektarbejde

#### FÆRDIGHEDER

- definere problembaseret læring med udgangspunkt i teori og egne erfaringer
- planlægge og styre et problembaseret projektarbejde under hensynstagen til den givne problemtype, projektets længde og gruppens sammensætning
- identificere, analysere og formulere en åben og kompleks problemstilling under hensynstagen til de menneskelige og samfundsmæssige sammenhænge i hvilke problemet indgår
- udpege relevante fokusområder, begreber og metoder til åben og bæredygtig problemløsning af komplekse problemer
- diskutere metodiske konsekvenser af forskellige videnskabsteoretiske positioner
- analysere, sammenstille og vurdere processerne i arbejdet med forskellige problemtyper
- analysere og vurdere gruppeprocesserne i det problemorienterede projektarbejde, herunder gruppens planlægning, monitorering og udvikling af gruppearbejdet

#### KOMPETENCER

- udvikle en studiepraksis, der er tilpasset et problembaseret, projektor organiseret og digitaliseret læringsmiljø
- udpege, afprøve og evaluere relevante teknikker og tilgange til at forbedre et problembaseret projektarbejde
- overføre erfaringer fra problembaserede projekter til handlingsanvisninger for lignende projekter
- vurdere egen progression i PBL på et erfaringsbaseret og læringsteoretisk grundlag.

#### UNDERVISNINGSFORM

Se § 17: Uddannelsens indhold og tilrettelæggelse

## EKSAMEN

### PRØVER

Prøvens navn	Problembaseret læring
Prøveform	Skriftlig
ECTS	5
Bedømmelsesform	Bestået/ikke bestået
Censur	Intern prøve
Vurderingskriterier	Vurderingskriterierne er angivet i Universitetets eksamensordning

## FAKTA OM MODULET

Engelsk titel	Problem Based Learning
Modulkode	TECENGPBLE20
Modultype	Kursus
Varighed	1 semester
Semester	Efterår
ECTS	5
Undervisningsprog	Engelsk
Tomplads	Ja
Undervisningssted	Campus Esbjerg
Modulansvarlig	<a href="#">Jette Egelund Holgaard</a>

## ORGANISATION

Studienævn	Studienævn for Planlægning og Landinspektøruddannelsen
Institut	Institut for Bæredygtighed og Planlægning
Fakultet	Det Teknisk Fakultet for IT og Design

# MICROPROCESSOR BASED SYSTEMS

**2023/2024**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

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

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

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

#### SKILLS

- Be about to choose, describe and apply relevant technical, scientific and context models, theories and methods for analysis, processing and problem solving in relation to microprocessor based systems
- Be able to perform critical evaluation of the relevance of the gained knowledge in relation to the project work including evaluation of the suitability of models, theories or methods
- Be able to design an embedded system operating with no human interactions
- Must be able to design a microprocessor program which can run on its own for controlling the digital/analogue outputs
- Must be able to elaborate a number of possibilities for analysis, program development, programming and testing for the entire microprocessor based system
- Be able to obtain data online using real-time data acquisition
- Be able to synthesize, document and bring the entire system (hardware and software) to working condition

#### COMPETENCES

- Be able to design a microprocessor based system based on the design specifications
- Independently identify and analyse embedded programs
- Independently be able to design and apply embedded programming
- Have a fundamental understanding of timers, counters, interrupts, analog and digital signals, and how these concepts can be applied
- Be able to implement and test the developed system with the purpose of verifying the hypothesis, as well as draw conclusions based on the achieved result.
- Be able to plan, control and put a project work in perspective including planning of project meetings and delegation of the work

#### TYPE OF INSTRUCTION

Problem based and project oriented project work in groups. The project can be discipline oriented, interdisciplinary or be a part of a multi-disciplinary project dependent on project choice The project work is documented in a P2 project report and participation in a presentation seminar.

#### EXTENT AND EXPECTED WORKLOAD

Since it is a 10 ECTS project module, the work load is expected to be 300 hours for the student.

## EXAM

### EXAMS

Name of exam	Microprocessor Based Systems
Type of exam	Oral exam based on a project Oral examination with external adjudicator based on the presentation seminar and project report.
ECTS	10
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	Mikroprocessor-baserede systemer
Module code	N-AIE-B2-1A
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	10
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	<a href="#">Dil Muhammad Akbar Hussain</a>

### ORGANISATION

Education owner	Bachelor of Science (BSc) in Engineering (Applied Industrial Electronics)
Study Board	Study Board of Build, Energy, Electronics and Mechanics in Esbjerg
Department	Department of Energy
Faculty	The Faculty of Engineering and Science

# GRUNDLÆGGENDE MEKANIK OG TERMODYNAMIK

## 2023/2024

### MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

#### LÆRINGSMÅL

##### VIDEN

- Skal have viden om Newtons love
- Skal have viden om statisk ligevægt
- Skal have viden om arbejde og effekt
- Skal have viden om kinetisk, potentiel og mekanisk energi
- Skal have viden om bevægelsesmængde
- Skal have viden om rotation og inertimoment
- Skal have viden om kraftmoment
- Skal have viden om termodynamikkens hovedsætninger
- Skal have viden om ideale gasser
- Skal have viden om varme, arbejde og indre energi
- Skal have viden om termodynamiske materialeegenskaber

##### FÆRDIGHEDER

- Skal kunne løse simple problemer inden for de emner der er opnået viden om

##### KOMPETENCER

- Skal kunne anvende teorier og metoder inden for mekanik og termodynamik på simple modelsystemer
- Skal kunne udvikle og styrke kendskab til, forståelse af og anvendelse af teorier og metoder i mekanik og termodynamik inden for andre fagområder
- Skal ud fra givne forudsætninger kunne ræsonnere og argumentere med begreber fra mekanik og termodynamik

##### UNDERVISNINGSFORM

Forelæsninger med tilhørende opgaveregning.

##### OMFANG OG FORVENTET ARBEJDSINDSAT

Kursusmodulets omfang er 5 ECTS svarende til 150 timers studieindsats.

### EKSAMEN

#### PRØVER

Prøvens navn	Grundlæggende mekanik og termodynamik
Prøveform	Skriftlig
ECTS	5
Bedømmelsesform	7-trins-skala
Censur	Intern prøve
Vurderingskriterier	Vurderingskriterierne er angivet i Universitetets eksamensordning

## FAKTA OM MODULET

Engelsk titel	Introduction to Mechanics and Thermodynamics
Modulkode	F-FYS-B2-3A
Modultype	Kursus
Varighed	1 semester
Semester	Forår
ECTS	5
Undervisningsprog	Dansk og engelsk
Tomplads	Ja
Undervisningssted	Campus Aalborg, Campus Esbjerg
Modulansvarlig	<a href="#">Thomas Tauris</a>

## ORGANISATION

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

# REALTIDSSYSTEMER OG PROGRAMMERINGSSPROG

## 2023/2024

### MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

Modulet bygger på viden opnået i modulet Anvendt ingeniørmatematik eller tilsvarende.

#### LÆRINGSMÅL

##### VIDEN

- Have viden om talsystemer anvendt i digitale computere og realtidssystemer (decimal, binær, hexadecimal), basale aritmetiske operatører og repræsentation af hel- og decimaltal
- Have viden om basale digitale logiske komponenter og enkle kombinatoriske kredsløb
- Have grundlæggende viden om bi-stable (flip-flops) komponenter og deres anvendelse i enkle synkrone sekventielle kredsløb
- Have forståelse for hvordan digitale signaler repræsenteres i forskellige elektriske logik-familier samt forstå deres statiske og dynamiske elektriske karakteristikker
- Have kendskab til metoder for programudvikling og kunne forstå udviklingsprocessen for et program fra problemformulering til endelig implementering
  
- Have kendskab til syntaksen for programmeringssproget C, herunder viden om hukommelsesstyring, datatyper og variable, kontrolstrukturer, funktioner samt brug af pointere
- Have grundlæggende kendskab til C-sprogets pre-processor, kompiler og linker samt brug af flere kildefiler og biblioteksfiler
- Have kendskab til brug af et integreret digitalt udviklingsmiljø til programudvikling i C og til fejlfinding
- Have grundlæggende forståelse for digitale mikrokontrollere, deres arkitektur og anvendelse i realtidssystemer
- Have kendskab til basale perifere enheder i mikrokontrollere, herunder digital input og output samt analog input og output
- Have kendskab til virkemåden for digital til analog konvertere og analog til digital konvertere samt deres praktiske anvendelse i en mikrokontroller
- Have kendskab til specielle perifere enheder, herunder pulsbreddemodulator og interface til en enkoder med kvadratur signaler
- Have kendskab til udvikling/fejlfinding af C-programmer til digitale mikrokontrollere anvendt i realtidsapplikationer med både interrupt service rutiner og ikke-tidskritiske rutiner
- Have kendskab til tidsdiskret implementering af digitale filtre, regulatorer og puls-breddemodulatorer i mikrokontrollere
- Have kendskab til metoder til grafisk programmering
- Have kendskab til programmering vha. dataflowteknikker ved brug af basale datatyper og kontrolstrukturer for både ikke-tidskritiske- og realtids-applikationer
- Have kendskab til anvendelse af integreret udviklingsmiljø for grafisk programmering og fejlfinding
- Have kendskab til digital hardware til brug ved dataopsamling

##### FÆRDIGHEDER

- Være i stand til at analysere, designe og realisere simple kombinatoriske og sekventielle logiske kredsløb
- Være i stand til at beskrive de væsentligste elektriske karakteristika for forskellige logikfamilier og forstå hvornår digitale interfacekredsløb skal anvendes
- Være i stand til at interface en digital mikrokontrollers perifere enheder til eksterne enheder (aktuatorer, sensorer, osv.) ved at tage hensyn til alle relevante elektriske forhold
- Være i stand til at udvælge et passende realtidssystem og tilhørende programmeringsmiljø til en given ingeniørmæssig problemstilling
- Være i stand til at neddele et program i mindre moduler, der kan programmeres, fejlfindes, og afprøves enkeltvist
- Være i stand til at udvikle digitale applikationer i programmeringssproget C og vha. grafisk programmering, der kan løse en given problemstilling, som kan have realtidskrav
- Være i stand til at planlægge, udføre og dokumentere eksperimenter, hvor en mikrokontroller anvendes i et realtidssystem med både analoge og digitale input og output.

## KOMPETENCER

- Skal selvstændigt kunne udføre design og udvikling inden for fagområdet realtidssystemer og deres programmering
- Skal selvstændigt være i stand til at videreudvikle egen viden og kompetencer inden for fagområdet ud over indholdet i dette kursusmodul

## UNDERVISNINGSFORM

Kurset afvikles som en blanding af forelæsninger, workshops, øvelser, selvstudium, e-læring og miniprojekt.

## OMFANG OG FORVENTET ARBEJDSINDSAT

Kursusmodulets omfang er 10 ECTS svarende til 300 timers studieindsats.

## EKSAMEN

### PRØVER

Prøvens navn	Realtidssystemer og programmeringssprog
Prøveform	Aktiv deltagelse/løbende evaluering Undervisningsdeltagelse med mindst 80% fremmøde samt godkendelse af miniprojekt, der kan udarbejdes gruppevis. Omfang ca. 10 sider (max. 2800 karakterer pr. side). Re-eksamen er mundtlig eksamen baseret på afleveret miniprojekt.
ECTS	10
Bedømmelsesform	Bestået/ikke bestået
Censur	Intern prøve
Vurderingskriterier	Vurderingskriterierne er angivet i Universitetets eksamensordning

## FAKTA OM MODULET

Engelsk titel	Real-Time Systems and Programming Languages
Modulkode	N-EN-B4-4BZ
Modultype	Kursus
Varighed	1 semester
Semester	Forår
ECTS	10
Undervisningssprog	Engelsk
Tomplads	Ja
Undervisningssted	Campus Aalborg, Campus Esbjerg
Modulansvarlig	<a href="#">Michael Møller Bech</a>

## ORGANISATION

Uddannelsesejer	Bachelor (BSc) i teknisk videnskab (energi)
Studienævn	Studienævn for Byggeri, Energi, Elektronik og Maskin i Esbjerg
Institut	Institut for Energi



Fakultet	Det Ingeniør- og Naturvidenskabelige Fakultet
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# LINEAR ALGEBRA

**2023/2024**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge from the module Calculus.

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

- Vectors, matrices and systems of linear equations
- Connections between solution of systems of linear equations, associated matrices and operations on those
- Linear independence and dimension. Eigenvalues and eigenvectors
- The connection between properties of a matrix and of the echelon form of it
- The connection between a vector space of dimension  $n$  and  $\mathbb{R}^n$
- Orthogonality and orthonormal bases

#### SKILLS

- Matrix-vector product, product and sum of matrices. Row operations. Gauss elimination.
- Eigenvalues and eigenspaces.
- Solution of a system of linear equations on vector form.
- Bases of subspaces associated with a matrix.
- Given a basis for a vector space finding coordinates for vectors and the matrix of a linear map.
- Gram Schmidt, projection on a subspace, projection matrices. Coordinates for a vector wrt. an orthonormal basis.

#### COMPETENCES

Can apply methods and concepts from linear algebra, including vector spaces and orthonormal bases to given problems relevant to the study programme.

#### TYPE OF INSTRUCTION

Lectures, exercises, videos, quiz, digitalised self-study, workshops on calculus problems relevant to the study programme.

#### EXTENT AND EXPECTED WORKLOAD

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

## EXAM

### EXAMS

Name of exam	Linear Algebra
Type of exam	Written or oral exam
ECTS	5
Permitted aids	Please see the semester description / module description
Assessment	7-point grading scale

Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

## FACTS ABOUT THE MODULE

Danish title	Lineær algebra
Module code	MATLIA1234GB
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	<a href="#">Morten Grud Rasmussen</a>

## ORGANISATION

Study Board	Study Board of Mathematical Sciences
Department	Department of Mathematical Sciences
Faculty	The Faculty of Engineering and Science

# INSTRUMENTATION

## 2023/2024

### CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

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

#### LEARNING OBJECTIVES

##### KNOWLEDGE

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

##### SKILLS

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

##### COMPETENCES

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

#### TYPE OF INSTRUCTION

Problem based and project organised project work in groups where the students, in the collaboration process to find the technical solutions, are focused on effective team work with the ability to listen actively, give constructive feedback and motivation in the collaboration as well as having responsibility for own learning. The project may be discipline-oriented, interdisciplinary or part of a multidisciplinary project depending on project choice.

#### EXTENT AND EXPECTED WORKLOAD

Since it is a 15 ECTS project module, the work load is expected to be 450 hours for the student.

### EXAM

#### EXAMS

Name of exam	Instrumentation
Type of exam	Oral exam based on a project

	Oral examination with external adjudicator based on a presentation seminar and project report.
ECTS	10
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	Instrumentering
Module code	N-AIE-B3-1B
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	10
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	<a href="#">Daniel Ortiz Arroyo</a>

## ORGANISATION

Education owner	Bachelor of Science (BSc) in Engineering (Applied Industrial Electronics)
Study Board	Study Board of Build, Energy, Electronics and Mechanics in Esbjerg
Department	Department of Energy
Faculty	The Faculty of Engineering and Science

# AC-KREDSLØBSTEORI

2023/2024

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

Modulet bygger på viden opnået i modulet elektriske grundfag eller tilsvarende.

### LÆRINGSMÅL

#### VIDEN

- Have opnået forståelse for:
  - Grundlæggende steady-state analyser inden for AC-kredsløb
  - Grundlæggende steady-state effekt analyser inden for AC-kredsløb
  - Koncepterne for gensidig induktans, koblingskoefficienter, den ideelle transformer og vindingsforhold
  - Karakteristika for balancerede trefasede kredsløb
  - Basale trefasede stjerne og delta koblinger
  - Variable frekvensforhold for basale R, L og C kredsløb
  - Karakteristika for basale filtre: lavpas, højpas, båndpas og båndstop
  - Forskellige typer af kredsløbsfunktioner
  - Definition af poler og nulpunkter
  - Laplace domæne repræsentation af grundlæggende kredsløbselementer (medtaget begyndelsesbetingelser): R, L og C
  - Karakteristika for dioder og passive enfasede og trefasede ensrettere
  - Fourier-teknikker til kredsløbsanalyse

#### FÆRDIGHEDER

- Kunne foretage beregninger af strømme og spændinger i steady-state AC-kredsløb
- Kunne foretage steady-state effektanalyser inden for AC-kredsløb
- Kunne foretage beregninger på magnetisk koblede kredsløb
- Kunne beregne spændinger, strømme, effekter og effektfaktor i trefasede kredsløb
- Kunne lave Bode-plot og frekvensanalyser for variable-frekvens kredsløb
- Kunne lave kredsløbsanalyser ved hjælp af Laplace transformation
- Kunne designe enfasede og trefasede diodeensrettere
- Kunne lave Fourier-analyser af periodiske signaler i elektriske kredsløb

#### KOMPETENCER

- Skal kunne håndtere enkle udviklingsorienterede situationer i forbindelse med AC-kredsløbstekniske problemstillinger i studie- eller arbejdssammenhænge.
- Skal kunne udføre laboratoriearbejde, lave dataopsamling og analysere resultaterne for AC-kredsløb under studie- og i arbejdssammenhænge

#### UNDERVISNINGSFORM

Forelæsninger med efterfølgende opgaveregning og laboratorieøvelser, evt. suppleret med e-læringsaktiviteter.

#### OMFANG OG FORVENTET ARBEJDSINDSAT

Kursusmodulets omfang er 5 ECTS svarende til 150 timers studieindsats.

## EKSAMEN

### PRØVER

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

### FAKTA OM MODULET

Engelsk titel	AC Circuit Theory
Modulkode	N-EN-B3-2BZ
Modultype	Kursus
Varighed	1 semester
Semester	Efterår
ECTS	5
Undervisningssprog	Engelsk
Tomplads	Ja
Undervisningssted	Campus Aalborg, Campus Esbjerg
Modulansvarlig	<a href="#">Erik Schaltz</a> , <a href="#">Amin Hajizadeh</a>

### ORGANISATION

Uddannelsesejer	Bachelor (BSc) i teknisk videnskab (energi)
Studienævn	Studienævn for Byggeri, Energi, Elektronik og Maskin i Esbjerg
Institut	Institut for Energi
Fakultet	Det Ingeniør- og Naturvidenskabelige Fakultet

# ANVENDT INGENIØRMATEMATIK

2023/2024

## ANBEFALEDE FAGLIGE FORUDSÆTNINGER FOR AT DELTAGE I MODULET

Modulet bygger på viden opnået i modulerne Calculus og Lineær algebra eller tilsvarende.

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

### LÆRINGSMÅL

#### VIDEN

- Skal have viden om grundlæggende regneregler inden for vektoranalyse i det 2 og 3 dimensionale rum, og hvordan de anvendes på ingeniørområdet
- Skal kunne forstå Laplace-transformation og anvende den til løsning af differentiaalligninger bla. eksemplificeret ved problemstillinger fra fx mekanik, elektronik eller varmeledning
- Skal have viden om komplekse analytiske funktioner
- Skal have forståelse for potensrækker og Taylor-rækker
- Skal have forståelse for hvordan komplekse analytiske funktioner og rækkeudviklinger kan anvendes i forhold til fysiske systemer

#### FÆRDIGHEDER

- Skal kunne anvende vektoranalyse, herunder:
  - Indre produkt (prik-produkt)
  - Vektor-produkt (kryds-produkt)
  - Vektor- og skalarfunktioner og felter
  - Vektor kurver, tangent og længde
  - Vektordifferentialregning: Gradient, divergens, rotation
  - Vektorintegralregning: Linje-integraler, kurveafhængighed af linje-integraler, dobbelt-integraler, Greens sætning i planet, overflade-integraler
- Skal kunne anvende Fourier-rækker, herunder:
  - Fourier-rækker og trigonometriske rækker
  - Periodiske funktioner
  - Lige og ulige funktioner
  - Komplekse Fourier-rækker
- Skal kunne anvende LaPlace-transformation, herunder:
  - Definition af LaPlace-transformation. Invers transformation. Linearitet og s-skifte
  - Transformation af almindelige funktioner, herunder periodiske, impuls og trin funktioner
  - Transformation af afledede og integraler
  - Løsning af differentiaalligninger
  - Foldning og integralligninger
  - Differentiation og integration af transformerede systemer med ordinære differentiaalligninger
- Skal kunne anvende komplekse analytiske funktioner inden for konform afbildning og komplekse integraler, herunder:
  - Komplekse tal og kompleks plan
  - Polær form for komplekse tal
  - Eksponentielle funktioner
  - Trigonometriske og hyperbolske funktioner
  - Logaritmiske funktioner og generelle potensfunktioner
  - Kompleks integration: Linje-integraler i det komplekse plan
  - Cauchys integral sætning



## KOMPETENCER

- Skal kunne håndtere vektoranalyse, rækker, LaPlace-transformation og komplekse analytiske funktioner på grundlæggende ingeniørmæssige eksempler

## UNDERVISNINGSFORM

Uddannelsen bygger på en kombination af faglige, problemorienterede og tværfaglige tilgange og tilrettelægges ud fra følgende arbejds- og evalueringsformer, der kombinerer færdigheder og faglig refleksion:

- forelæsninger
- klasseundervisning
- projektarbejde
- workshops
- opgaveløsning (individuel og i grupper)
- lærerfeedback
- faglig refleksion
- porteføljearbejde
- laboratoriearbejde
- e-learning

## OMFANG OG FORVENTET ARBEJDSINDSAT

Kursusmodulets omfang er 5 ECTS svarende til 150 timers studieindsats.

## EKSAMEN

### PRØVER

Prøvens navn	Anvendt ingeniørmatematik
Prøveform	Skriftlig 4 timers prøve
ECTS	5
Bedømmelsesform	7-trins-skala
Censur	Intern prøve
Vurderingskriterier	Vurderingskriterierne er angivet i Universitetets eksamensordning

## FAKTA OM MODULET

Engelsk titel	Applied Engineering Mathematics
Modulkode	24ETMATDELE2
Modultype	Kursus
Varighed	1 semester
Semester	Efterår
ECTS	5
Undervisningsprog	Engelsk
Tomplads	Ja
Undervisningssted	Campus Aalborg, Campus Esbjerg
Modulansvarlig	<a href="#">Morten Nielsen</a> , <a href="#">Anne Marie Svane</a>

## ORGANISATION

Studienævn	Studienævn for Matematiske Fag
Institut	Institut for Matematiske Fag
Fakultet	Det Ingeniør- og Naturvidenskabelige Fakultet

# ELEKTRISKE GRUNDFAG

2023/2024

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

### LÆRINGSMÅL

#### VIDEN

- Have opnået viden om og forståelse for resistive elektriske kredsløb
- Have opnået viden om og forståelse for operationsforstærkere
- Have opnået viden om og forståelse for induktive og kapacitive elektriske kredsløb
- Have opnået viden om og forståelse for elektrisk måleteknik
- Have opnået viden om forskellige elektriske læresætninger
- Have opnået viden om og forståelse for laboratorieprocedurer i forbindelse med el-tekniske laboratorieforsøg

#### FÆRDIGHEDER

- Kunne analysere enkle og sammensatte elektriske DC-kredse
- Kunne anvende kredsløbsteorien til at beregne strømme, spændinger, energier og effekter i DC-kredse
- Kunne anvende kredsløbsreduktionsmetoder til at reducere elektriske kredse
- Kunne anvende analyse metoder til at designe operationsforstærkerkoblinger
- Kunne planlægge og udføre velgennemtænkte, succesfulde el-tekniske laboratorieforsøg på en sikker og hensigtsmæssig vis
- Kunne anvende softwareværktøj til design af elektriske kredse
- Have færdigheder inden for følgende områder:
  - Grundlæggende DC-kredsløbsteori (indeholdende energilagrende komponenter), Ohms lov, enheder, Kirchhoffs love, kredsløbsreduktioner (serie og parallel), stjerne-trekant koblinger, afhængige og uafhængige kilder, knudepunkts- og maskemetoden, grundlæggende operationsforstærkerkoblinger, den ideelle operationsforstærker, Thévenin og Nortons teoremer, superposition og maksimal effektoverføring, første og anden ordens transienter
  - Måling af strøm, spænding, effekt og energi, anvendelse af almindelige elektriske måleinstrumenter som voltmeter, amperemeter, wattmeter i digital teknologi samt oscilloskoper
  - Målenøjagtighed, sammensat målefejl og usikkerhedsberegninger
- Kunne anvende software til beregninger af forskellige elektriske signaler i enkle elektriske kredse

#### KOMPETENCER

- Skal kunne håndtere enkle udviklingsorienterede situationer i forbindelse med elektriske kredse og laboratorieopstillinger i studie- eller arbejdssammenhænge
- Skal selvstændigt kunne indgå i fagligt og tværfagligt samarbejde med en professionel tilgang inden for grundlæggende DC-kredsløbsteori
- Skal kunne identificere egne læringsbehov og strukturere egen læring inden for grundlæggende kredsløbsteori og el-tekniske laboratorieforsøg.

#### UNDERVISNINGSFORM

Forelæsninger med tilhørende opgaveregning evt. suppleret med e-learning i henhold til §17 i bachelorstudieordningen og §18 i diplomingeniørstudieordningen.

#### OMFANG OG FORVENTET ARBEJDSINDSAT

Kursusmodulets omfang er 5 ECTS svarende til 150 timers studieindsats.

## EKSAMEN

### FORUDSÆTNING FOR INDSTILLING TIL PRØVEN

- Der er obligatorisk deltagelse i alle kursusgange med laboratorieøvelser samt krav om aflevering af samtlige skriftlige laboratorierapporter.
- I tilfælde af manglende deltagelse i laboratorieøvelser eller manglende aflevering af skriftlige laboratorierapporter skal den studerende deltage i en ekstraordinær laboratorieøvelse, som finder sted inden re-eksamen afholdes.

### PRØVER

Prøvens navn	Elektriske grundfag
Prøveform	Skriftlig 4 timers prøve.
ECTS	5
Bedømmelsesform	7-trins-skala
Censur	Intern prøve
Vurderingskriterier	Vurderingskriterierne er angivet i Universitetets eksamensordning

### FAKTA OM MODULET

Engelsk titel	Introduction to Electrical Engineering
Modulkode	N-AIE-B3-3A
Modultype	Kursus
Varighed	1 semester
Semester	Efterår
ECTS	5
Undervisningssprog	Engelsk
Tomplads	Ja
Undervisningssted	Campus Esbjerg
Modulansvarlig	<a href="#">Filipe Miguel Faria da Silva</a> , <a href="#">Mohsen N. Soltani</a>

### ORGANISATION

Uddannelsesejer	Bachelor (BSc) i teknisk videnskab (anvendt industriel elektronik)
Studienævn	Studienævn for Byggeri, Energi, Elektronik og Maskin i Esbjerg
Institut	Institut for Energi
Fakultet	Det Ingeniør- og Naturvidenskabelige Fakultet

# DATA STRUCTURES AND ALGORITHMS

**2023/2024**

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

The module is based on knowledge achieved in the module Real-time systems and programming languages or similar.

### LEARNING OBJECTIVES

#### KNOWLEDGE

- Have knowledge about object-oriented programming using a modern computer language such as Python or C++
- Have knowledge about abstract data types
- Have knowledge about algorithm analysis, complexity classes and recursion
- Have knowledge about data structures such as stacks, queues, lists, sets, maps, trees and graphs
- Have knowledge about sorting algorithms such as insertion sort, merge sort and quick sort
- Have knowledge about searching algorithms and heuristics

#### SKILLS

- Be able to use, design and implement data structures within a computer program
- Be able to analyse the complexity of algorithms in time and space using the big O notation
- Be able to design and write computer programs using object-oriented techniques and data structures
- Be able to design and implement divide and conquer algorithms using recursion

#### COMPETENCES

- Independently demonstrate knowledge and capacity to apply algorithms and heuristics to design solutions for problems in different application domains
- Independently design computer programs with efficient data structures and algorithms
- Independently design and use classes and objects to implement computer programs for real time systems

#### TYPE OF INSTRUCTION

Lectures with exercises, possibly supplemented with e-learning as stated in § 17 in the BSc curriculum and §18 in the BE curriculum.

#### EXTENT AND EXPECTED WORKLOAD

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

## EXAM

### EXAMS

Name of exam	Data Structures and Algorithms
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	Datastrukturer og algoritmer
Module code	N-AIE-B3-4A
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	<a href="#">Daniel Ortiz Arroyo</a>

## ORGANISATION

Education owner	Bachelor of Science (BSc) in Engineering (Applied Industrial Electronics)
Study Board	Study Board of Build, Energy, Electronics and Mechanics in Esbjerg
Department	Department of Energy
Faculty	The Faculty of Engineering and Science

# CONTROL SYSTEMS

**2023/2024**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

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

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

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

#### SKILLS

- Be able to analyse and select methods for modelling of physical systems, such as electric, electro-mechanical, thermal and fluid dynamical systems, or power electronic systems at a level where the resulting models can be utilized in a control system design
- Be able to set up a specific goal for the project
- Be able to apply selected modeling techniques for modeling dynamic systems and simulating them
- Be able to analyse the open-loop and closed-loop system features and specify system performances in transfer function descriptions
- Be able to apply basic linear control techniques for analysis and design of a control system based on a given specification
- 

#### COMPETENCES

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

#### TYPE OF INSTRUCTION

Project based, project organised project work in groups where the solution emerges as an iterative process with reflections on set sub-goals and analyses, and where the personal collaboration skills and tolerance and robustness towards others' inputs are strengthened through the group collaboration. The project may be discipline-oriented, interdisciplinary or part of a multidisciplinary project, depending on project choice.

#### EXTENT AND EXPECTED WORKLOAD

Since it is a 15 ECTS project module, the work load is expected to be 450 hours for the student.

## EXAM

### EXAMS

Name of exam	Control Systems
Type of exam	Oral exam based on a project Oral examination with internal adjudicator based on a presentation seminar and project report.
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	Styring og regulering
Module code	N-AIE-B4-1A
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	<a href="#">Amin Hajizadeh</a>

### ORGANISATION

Education owner	Bachelor of Science (BSc) in Engineering (Applied Industrial Electronics)
Study Board	Study Board of Build, Energy, Electronics and Mechanics in Esbjerg
Department	Department of Energy
Faculty	The Faculty of Engineering and Science



# GRUNDLÆGGENDE REGULERING

2023/2024

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

Modulet bygger på viden opnået i modulerne Calculus, Lineær algebra og Anvendt ingeniørmatematik eller tilsvarende.

### LÆRINGSMÅL

#### VIDEN

- Skal have viden om modellering af fysiske systemer og deres dynamik
- Skal have viden om metoder til linearisering af ulineære systemer
- Skal have forståelse for et systems stationære egenskaber og dynamiske respons, herunder indflydelse af systemets type og orden samt placering af poler og nulpunkter
- Skal have forståelse for åben- og lukket-sløjfe-begreberne
- Skal have forståelse for et systems frekvensrespons
- Skal have forståelse for absolut og relativ stabilitet og metoder til analyse af stabilitet
- Skal have forståelse for rodkurve-analyse og viden om regulatordesign vha. rodkurver
- Skal have forståelse for regulatordesign vha. frekvensresponsteknikker
- Skal have viden om praktisk implementering af regulatorer

#### FÆRDIGHEDER

- Skal kunne modellere og analysere enkle dynamiske systemer (elektriske, mekaniske og termiske), samt have forståelse for analogierne mellem disse
- Skal kunne opstille lineære modeller af dynamiske systemer vha. blokdiagrammer og overføringsfunktioner
- Skal kunne anvende reguleringsteori til at specificere performancekriterier
- Skal kunne analysere et systems respons og stabilitet vha. de lineære metoder
- Skal kunne udvælge passende lineære regulatorer og forudsige/vurdere deres indflydelse på et givet system
- Skal kunne dimensionere en lineær regulator til et givet system, således performancekrav overholdes
- Skal kunne vurdere problemstillingen og den anvendte løsningsmetode samt formidle resultatet heraf til et teknisk publikum

#### KOMPETENCER

- Skal kunne håndtere udviklingsorienterede situationer i forbindelse med grundlæggende reguleringsteknik og modellering
- Skal selvstændigt kunne indgå i fagligt og tværfagligt samarbejde med en professionel tilgang inden for grundlæggende reguleringsteknik og modellering
- Skal kunne identificere egne læringsbehov og strukturere egen læring inden for grundlæggende reguleringsteknik og modellering

#### UNDERVISNINGSFORM

Uddannelsen bygger på en kombination af faglige, problemorienterede og tværfaglige tilgange og tilrettelægges ud fra følgende arbejds- og evalueringsformer, der kombinerer færdigheder og faglig refleksion:

- forelæsninger
- klasseundervisning
- projektarbejde
- workshops
- opgaveløsning (individuel og i grupper)
- lærerfeedback
- faglig refleksion
- porteføljearbejde
- laboratoriearbejde
- e-læring

## OMFANG OG FORVENTET ARBEJDSINDSAT

Kursusmodulets omfang er 5 ECTS svarende til 150 timers studieindsats.

## EKSAMEN

### PRØVER

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

## FAKTA OM MODULET

Engelsk titel	Fundamental Control Theory
Modulkode	N-EN-B4-2AZ
Modultype	Kursus
Varighed	1 semester
Semester	Forår
ECTS	5
Undervisningssprog	Engelsk
Tomplads	Ja
Undervisningssted	Campus Aalborg, Campus Esbjerg
Modulansvarlig	<a href="#">Henrik C. Pedersen</a> , <a href="#">Zhenyu Yang</a>

## ORGANISATION

Uddannelsesejer	Bachelor (BSc) i teknisk videnskab (energi)
Studienævn	Studienævn for Byggeri, Energi, Elektronik og Maskin i Esbjerg
Institut	Institut for Energi
Fakultet	Det Ingeniør- og Naturvidenskabelige Fakultet

# MEKANIK

2023/2024

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

Modulet bygger på viden opnået i modulet Grundlæggende mekanik og termodynamik eller tilsvarende.

### LÆRINGSMÅL

#### VIDEN

- Skal have forståelse for begreber som kraft, moment og statisk ligevægt
- Skal have forståelse for arealinertimomenter og masseinertimomenter
- Skal have forståelse for kinematik af stive legemer
- Skal have forståelse for kinetik af stive legemer og systemer af legemer på planart niveau
- Skal have viden om 3D kinetik af stive legemer
- Skal have forståelse for grundlæggende faststofmekanik, herunder tøjning, spænding og torsion
- Skal have forståelse for spændinger i homogene bjælker (herunder aksler), herunder spændingspåvirkning ved træk/tryk, vridning og udbøjning
- Skal have viden om udbøjning af bjælker under lastpåvirkning

#### FÆRDIGHEDER

- Skal kunne udvælge passende understøtninger/indspændinger for at kunne analysere mekaniske strukturer og enkeltdele
- Skal kunne analysere stive plane mekaniske strukturer, såvel statisk som dynamisk
- Skal kunne bestemme arealinertimomenter og masseinertimomenter af udvalgte elementer
- Skal kunne beskrive de kræfter og påvirkning der er på stive legemer i 3D
- Skal kunne analysere bjælkeelementer mht. tøjning og spænding under forskellige belastningssituationer
- Skal kunne analysere grundlæggende tilfælde af udbøjning af bjælker

#### KOMPETENCER

- Skal kunne benytte de tilegnede færdigheder til udvikling og analyse af mekaniske systemer
- Skal selvstændigt kunne indgå i fagligt og tværfagligt samarbejde med en professionel tilgang inden for mekaniske systemer
- Skal kunne identificere egne læringsbehov og strukturere egen læring inden for mekanik

#### UNDERVISNINGSFORM

Uddannelsen bygger på en kombination af faglige, problemorienterede og tværfaglige tilgange og tilrettelægges ud fra følgende arbejds- og evalueringsformer, der kombinerer færdigheder og faglig refleksion:

- forelæsninger
- klasseundervisning
- projektarbejde
- workshops
- opgaveløsning (individuel og i grupper)
- lærerfeedback
- faglig refleksion
- porteføljearbejde
- laboratoriearbejde
- e-læring

#### OMFANG OG FORVENTET ARBEJDSINDSAT

Kursusmodulets omfang er 5 ECTS svarende til 150 timers studieindsats.

## EKSAMEN

### PRØVER

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

### FAKTA OM MODULET

Engelsk titel	Mechanics
Modulkode	M-N-ENB4-3AZ
Modultype	Kursus
Varighed	1 semester
Semester	Forår
ECTS	5
Undervisningssprog	Engelsk
Tomplads	Ja
Undervisningssted	Campus Aalborg, Campus Esbjerg
Modulansvarlig	<a href="#">Jørgen Asbøll Kepler</a>

### ORGANISATION

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

# MODELLING AND SIMULATION

**2023/2024**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

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

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

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

#### SKILLS

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

#### COMPETENCES

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

#### TYPE OF INSTRUCTION

The 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

- Work shops
- Exercises (individually and in groups)
- E-learning
- Supervisor feedback
- Professional reflection
- Portfolio work
- Laboratory work

## EXTENT AND EXPECTED WORKLOAD

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

## EXAM

### EXAMS

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

## FACTS ABOUT THE MODULE

Danish title	Modellering og simulering
Module code	N-AIE-B4-2A
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	<a href="#">Petar Durdevic</a>

## ORGANISATION

Education owner	Bachelor of Science (BSc) in Engineering (Applied Industrial Electronics)
Study Board	Study Board of Build, Energy, Electronics and Mechanics in Esbjerg
Department	Department of Energy
Faculty	The Faculty of Engineering and Science

# AUTOMATION INCLUDING POWER ELECTRONICS

## 2023/2024

### CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

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

#### LEARNING OBJECTIVES

##### KNOWLEDGE

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

##### SKILLS

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

##### COMPETENCES

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

#### TYPE OF INSTRUCTION

Problem based and project oriented work in project groups.

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

#### EXTENT AND EXPECTED WORKLOAD

Since it is a 15 ECTS project module, the work load is expected to be 450 hours for the student.

### EXAM

#### EXAMS

Name of exam	Automation including Power Electronics
Type of exam	Oral exam based on a project Oral examination with external examiner based on a presentation of the project report.
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
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## FACTS ABOUT THE MODULE

Danish title	Automatisering med anvendt effektelektronik
Module code	N-AIE-B5-1A
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	<a href="#">Anders Schmidt Kristensen</a>
Time allocation for external examiners	B

## ORGANISATION

Education owner	Bachelor of Science (BSc) in Engineering (Applied Industrial Electronics)
Study Board	Study Board of Build, Energy, Electronics and Mechanics in Esbjerg
Department	Department of Energy
Faculty	The Faculty of Engineering and Science



# MODERNE DIGITAL REGULERING

2023/2024

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

Modulet bygger på viden opnået i modulet Grundlæggende regulering eller tilsvarende.

### LÆRINGSMÅL

#### VIDEN

- Have viden om digital tilstandsmodellering og formulering af systemer på tilstandsform
- Have viden om kanoniske former og sammenhæng med overføringsfunktioner
- Have viden om et systems opførsel og stabilitet i relation til systemets egenværdier
- Have viden om styrbarhed og observerbarhed
- Have viden om polplacering og observerdesign
- Have viden om diskretisering (sampling) og rekonstruktion af tidskontinuerte digitale signaler
- Have viden om metoder til analyse af diskret-tidssignaler og -systemer (Z-transformation)
- Have viden om metoder til design af diskret-tids-regulatorer
- Have viden om metoder til diskretisering af tidskontinuerte regulatorer

#### FÆRDIGHEDER

- Kunne modellere tidskontinuerte lineære dynamiske systemer på tilstandsform med digitale beregningsværktøjer
- Kunne løse tilstandsligningen og kunne analysere et systems respons og stabilitet ud fra en tilstandsmodel
- Kunne designe både tilstandsregulator og tilstandsobserver til et tidskontinuert system
- Kunne modellere og analysere tidsdiskrete systemer i både åbent- og lukket-sløjfe
- Kunne vælge samplingstid via digital regulering
- Kunne opstille performancekrav til et lukket-sløjfe system og kunne udvælge diskret-tids-regulatorstruktur
- Kunne designe diskret-tids-regulator direkte i z-domænet
- Kunne anvende metoder til diskretisering af tidskontinuert digital regulator og være i stand til at vurdere resultatets anvendelighed
- Have forståelse for den praktiske implementering af tidsdiskrete digitale regulatorer

#### KOMPETENCER

- Kunne håndtere udviklingsorienterede situationer i forbindelse med digital tilstandsregulering og diskret regulering
- Selvstændigt kunne indgå i fagligt og tværfagligt samarbejde med en professionel tilgang til digital tilstandsregulering og diskret regulering
- Kunne identificere egne læringsbehov og strukturere egen læring inden for digital tilstandsregulering og diskret regulering

#### UNDERVISNINGSFORM

Uddannelsen bygger på en kombination af faglige, problemorienterede og tværfaglige tilgange og tilrettelægges ud fra følgende arbejds- og evalueringsformer, der kombinerer færdigheder og faglig refleksion:

- forelæsninger
- klasseundervisning
- projektarbejde
- workshops
- opgaveløsning (individuelt og i grupper)
- lærerfeedback
- faglig refleksion
- porteføljearbejde
- laboratoriearbejde
- e-læring

## OMFANG OG FORVENTET ARBEJDSINDSAT

Kursusmodulets omfang er 5 ECTS svarende til 150 timers studieindsats.

## EKSAMEN

### PRØVER

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

## FAKTA OM MODULET

Engelsk titel	Modern and Digital Control
Modulkode	N-EN-BE5-2B
Modultype	Kursus
Varighed	1 semester
Semester	Efterår
ECTS	5
Undervisningssprog	Dansk og engelsk
Tomplads	Ja
Undervisningssted	Campus Esbjerg
Modulansvarlig	<a href="#">Mohsen N. Soltani</a>

## ORGANISATION

Uddannelsesejer	Bachelor (BSc) i teknisk videnskab (energi)
Studienævn	Studienævn for Byggeri, Energi, Elektronik og Maskin i Esbjerg
Institut	Institut for Energi
Fakultet	Det Ingeniør- og Naturvidenskabelige Fakultet

# ELEKTRISKE MASKINER

**2023/2024**

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

Modulet bygger på viden opnået i modulerne Lineær algebra, Calculus, Anvendt ingeniørmatematik samt AC kredsløbsteori eller tilsvarende

### LÆRINGSMÅL

#### VIDEN

- Have grundlæggende viden om elektromagnetiske fænomener, driftsmåden samt opbygningen af transformere og elektriske maskiner
- Have viden om flux, flux-sammenkobling, fase induktanser og gensidig induktans og deres karakteristika
- Have grundlæggende viden om elektromekanisk energiomformning
- Have viden om trefasede vindinger og roterende magnetiske felter
- Have viden om maskinmaterialer og deres karakteristika samt praktiske forhold og standarder for elektriske maskiner
- Have viden om transformere, DC-, AC- og synkronmaskiner og fastlæggelsen af deres parametre ved test og opstilling af digitale steady-state ækvivalentkredsløbsmodeller herfor under forskellige driftsbetingelser

#### FÆRDIGHEDER

- Kunne lave beregninger på ækvivalentkredsløbsmodeller for transformere og elektriske maskiner
- Kunne lave nødvendige simplificeringer af transformerens ækvivalentdiagram ved forskellige applikationer
- Kunne tegne vektordiagrammer for transformeren og elektriske maskiner
- Kunne beregne effekt, moment, hastighed, strøm, effektfaktor og virkningsgrad for transformere og elektriske maskiner
- Kunne udføre eksperimentelle forsøg til fastlæggelse af ønskede parametre for transformere og elektriske maskiner

#### KOMPETENCER

- Være i stand til at anvende ækvivalentkredsløbsdiagrammer for transformere, synkronmaskiner og asynkronmaskiner og analysere deres performance under forskellige driftsbetingelser
- Være i stand til at udføre laboratoriemålinger til fastlæggelse af ønskede parametre for digitale ækvivalentdiagrammodeller
- Være i stand til at håndtere udviklingspecifikke situationer relateret til steady-state design, analyse og anvendelse af transformere og elektriske maskiner

#### UNDERVISNINGSFORM

Forelæsninger, opgaver og laboratorieøvelser samt evt. e-læring via digitale platforme.

#### OMFANG OG FORVENTET ARBEJDSINDSAT

Kursusmodulets omfang er 5 ECTS svarende til 150 timers studieindsats.

### EKSAMEN

#### PRØVER

Prøvens navn	Elektriske maskiner
Prøveform	Skriftlig eller mundtlig

ECTS	5
Bedømmelsesform	7-trins-skala
Censur	Intern prøve
Vurderingskriterier	Vurderingskriterierne er angivet i Universitetets eksamensordning

## FAKTA OM MODULET

Engelsk titel	Electrical Machines
Modulkode	N-EN-B5-5B
Modultype	Kursus
Varighed	1 semester
Semester	Efterår
ECTS	5
Undervisningssprog	Dansk og engelsk
Tomplads	Ja
Undervisningssted	Campus Aalborg, Campus Esbjerg
Modulansvarlig	<a href="#">Kaiyuan Lu</a> , <a href="#">Sanjeevikumar Padmanaban</a> , <a href="#">Dong Wang</a>

## ORGANISATION

Uddannelsesejer	Bachelor (BSc) i teknisk videnskab (energi)
Studienævn	Studienævn for Energi
Institut	Institut for Energi
Fakultet	Det Ingeniør- og Naturvidenskabelige Fakultet

# EFFEKTELEKTRONIK

**2023/2024**

## ANBEFALEDE FAGLIGE FORUDSÆTNINGER FOR AT DELTAGE I MODULET

Modulet bygger på viden opnået i modulerne Elektriske grundfag og AC-kredsløbsteori eller tilsvarende.

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

### LÆRINGSMÅL

#### VIDEN

- Have viden om teorier for effektiv energiomsætning vha. effektelektroniske systemer og apparater
- Have kendskab til effektelektroniske komponenters funktion og virkemåde
- Have viden om og forstå hvordan effektelektroniske systemer, apparater og komponenter modelleres
- Have viden om værktøjer til modellering

#### FÆRDIGHEDER

- Kunne anvende viden om energieffektive effektelektroniske systemer, apparater og deres komponenter til simulering
- Kunne vurdere resultatet af modelleringen, i hvor stort omfang det er repræsentativt for den fysiske verden
- Kunne forholde sig til modeller på forskellige abstraktionsniveauer og deres anvendelser

#### KOMPETENCER

- Have opnået evne til at kunne omsætte akademiske kundskaber og færdigheder inden for analyse af effektive effektelektroniske systemer, apparater og deres komponenter til en praktisk problemstilling og kunne bearbejde en sådan problemstilling
- Have opnået evne til at kunne indgå i fagligt og tværfagligt samarbejde inden for effektelektroniske systemer

#### UNDERVISNINGSFORM

Uddannelsen bygger på en kombination af faglige, problemorienterede og tværfaglige tilgange og tilrettelægges ud fra følgende arbejds- og evalueringsformer, der kombinerer færdigheder og faglig refleksion:

- forelæsninger
- klasseundervisning
- projektarbejde
- workshops
- opgaveløsning (individuel og i grupper)
- lærerfeedback
- faglig refleksion
- porteføljearbejde
- laboratoriearbejde
- evt. e-learning

#### OMFANG OG FORVENTET ARBEJDSINDSAT

Kursusmodulets omfang er 5 ECTS svarende til 150 timers studieindsats.

## EKSAMEN

### PRØVER

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

## FAKTA OM MODULET

Engelsk titel	Power Electronics
Modulkode	N-EN-B5-4B
Modultype	Kursus
Varighed	1 semester
Semester	Efterår
ECTS	5
Undervisningssprog	Dansk og engelsk
Tomplads	Ja
Undervisningssted	Campus Aalborg, Campus Esbjerg
Modulansvarlig	<a href="#">Stig Munk-Nielsen</a> , <a href="#">Frede Blaabjerg</a> , <a href="#">Asger Bjørn Jørgensen</a>

## ORGANISATION

Uddannelsesejer	Bachelor (BSc) i teknisk videnskab (energi)
Studienævn	Studienævn for Energi
Institut	Institut for Energi
Fakultet	Det Ingeniør- og Naturvidenskabelige Fakultet

# **BACHELOR PROJECT: MODELLING AND CONTROL OF INDUSTRIAL ELECTRONIC APPLICATIONS**

**2023/2024**

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

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

### **LEARNING OBJECTIVES**

#### **KNOWLEDGE**

- Have knowledge about control of industrial electronic applications in forms of apparatus or systems including power electronics, electric drives or motion controls for applications such as robotic systems, electric propulsion systems, electric and autonomous vehicles, etc.
- Have development-based knowledge and understanding within the profession and the discipline's practice and applied theories and methods
- Be able to understand scientific methods and theories compared to the semester theme and be able to see the project in a larger context

#### **SKILLS**

- Be able to apply knowledge about designing power electronics system, electrical drive and/or motion control for applications such as robotic systems, electric propulsion systems, electric and autonomous vehicles, etc. using digital platforms
- Be able to apply the discipline's methods and tools and master the skills associated with employment in the profession
- Be able to assess practical and theoretical issues and the reasons for and select the options
- Be able to present practical and professional issues and solutions to partners and user
- Be able to analyse results from simulations and laboratory work or real measured data series, and assemble them to give an overall impression of the system's performance

#### **COMPETENCES**

- Have the ability to provide robust time and work plans for own project.
- Be able to handle complex and development-oriented situations in study or work contexts within electrical machine and power electronics and/or motion controls for applications such as robotic systems, electric propulsion systems, electric and autonomous vehicles etc
- Have the ability to enter into professional and interdisciplinary collaboration with a professional approach in the field as electrical machine and drives and power electronic engineering and/or motion controls for applications such as robotic systems, electric propulsion systems, electric and autonomous vehicles etc
- Be able to identify own learning needs and structure learning in different environments in industrial electronics
- Be able to translate academic knowledge and skills in the field of industrial electronics including electrical machines, power electronic and/or motion controls for applications such as robotic systems, electric propulsion systems, electric and autonomous vehicles etc to a practical problem

#### **TYPE OF INSTRUCTION**

Problem based and project organised work in project groups focused on self-critical reflection and proactive participation. The project may be discipline-oriented, interdisciplinary or part of a multidisciplinary project depending on project choice.

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

Since it is a 15 ECTS project module, the work load is expected to be 450 hours for the student.

## EXAM

### EXAMS

Name of exam	Bachelor Project: Modelling and Control of Industrial Electronic Applications
Type of exam	Master's thesis/final project Oral examination with external examiner based on a presentation of the project report.
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	Bachelorprojekt: Modelling og styring af industrielle elektroniske applikationer
Module code	N-AIE-B6-5B
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	<a href="#">Amin Hajizadeh</a>

### ORGANISATION

Education owner	Bachelor of Science (BSc) in Engineering (Applied Industrial Electronics)
Study Board	Study Board of Build, Energy, Electronics and Mechanics in Esbjerg
Department	Department of Energy
Faculty	The Faculty of Engineering and Science



# NUMERISKE METODER

2023/2024

## ANBEFALEDE FAGLIGE FORUDSÆTNINGER FOR AT DELTAGE I MODULET

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

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

### LÆRINGSMÅL

#### VIDEN

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

#### FÆRDIGHEDER

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

#### KOMPETENCER

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

#### UNDERVISNINGSFORM

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

#### OMFANG OG FORVENTET ARBEJDSINDSAT

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

## EKSAMEN

### PRØVER

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

### FAKTA OM MODULET

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

### ORGANISATION

Uddannelsesejer	Civilingeniør, cand.polyt. i indeklima og energi
Studienævn	Studienævn for Mekanik og Fysik
Institut	Institut for Materialer og Produktion
Fakultet	Det Ingeniør- og Naturvidenskabelige Fakultet

# MODELLING AND CONTROL OF ROBOT MANIPULATOR

**2023/2024**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

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

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

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

#### SKILLS

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

#### COMPETENCES

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

### TYPE OF INSTRUCTION

The 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
- Work shops
- Exercises (individually and in groups)
- E-learning
- Supervisor feedback
- Professional reflection
- Portfolio work
- Laboratory work

### EXTENT AND EXPECTED WORKLOAD

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

## EXAM

### EXAMS

Name of exam	Modelling and Control of Robot Manipulator
Type of exam	Written or oral exam
ECTS	5
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	Modellering og regulering af robotter
Module code	N-AIE-B6-3A
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	<a href="#">Petar Durdevic</a>

### ORGANISATION

Education owner	Bachelor of Science (BSc) in Engineering (Applied Industrial Electronics)
Study Board	Study Board of Build, Energy, Electronics and Mechanics in Esbjerg
Department	Department of Energy
Faculty	The Faculty of Engineering and Science

# TEST AND VALIDATION INCLUDING SYSTEM SET-UP AND UNDERSTANDING

**2023/2024**

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

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

### LEARNING OBJECTIVES

#### KNOWLEDGE

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

#### SKILLS

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

#### COMPETENCES

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

#### TYPE OF INSTRUCTION

Lectures, laboratory work and practical exercises.

#### EXTENT AND EXPECTED WORKLOAD

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

## EXAM

### EXAMS

Name of exam	Test and Validation including System Set-up and Understanding
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	Test og validering inklusiv systemopbygning og -forståelse
Module code	N-AIE-B6-4A
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	<a href="#">Daniel Ortiz Arroyo</a>

### ORGANISATION

Education owner	Bachelor of Science (BSc) in Engineering (Applied Industrial Electronics)
Study Board	Study Board of Build, Energy, Electronics and Mechanics in Esbjerg
Department	Department of Energy
Faculty	The Faculty of Engineering and Science

# CYBER-PHYSICAL SYSTEMS

**2023/2024**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

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

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

- Have insight on the modeling of a system and the computational aspects in hardware (HW) and software (SW) needed to implement cyber-physical systems
- Have insight on how to implement digital communication within the components of a cyber-physical system using libraries
- Be able to understand how to use discrete time to model the cyber or computational part and continuous time to model the physical world
- Be able to understand basic concepts in operating systems, concurrency, finite state machines or flow charts to design the software of a cyber-physical system
- Be able to understand the effect of the HW components and SW algorithms on the overall performance of a cyber-physical system
- Be able to understand and create an business case for the cyber-physical system
- Energy digital auditing and sensor placement in energy assets for predictive control maintenance

#### SKILLS

- Be able to design cyber-physical systems that include digital controllers, their algorithms and their implementation in HW and SW
- Be able to simulate parts or the whole of a cyber-physical system using data-flow based tools such as Matlab Simulink, LabVIEW, Microprocessors or other industrial platform software
- Be able to design and implement the SW of a cyber-physical system using high-level computer languages and libraries
- Be able to implement the interface of a cyber-physical system to the physical world using ADC, DAC, microprocessor systems, sensors and actuators
- Be able to use a cyber-physical systems approach to design, implement and solve an engineering problem in industry 4.0, IoT, robotics or within the energy sector and power electronics.
- Be able to make a cost-benefit analysis of the cyber-physical system

#### COMPETENCES

- Be able to design a cyber-physical system in a professional way
- Be able to perform real-time analysis and programming of the designed system
- Be able to evaluate the basic economic conditions for the development and commissioning of the cyber-physical system

#### TYPE OF INSTRUCTION

Problem based and project oriented work in project groups.

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

#### EXTENT AND EXPECTED WORKLOAD

Since it is a 15 ECTS project module, the work load is expected to be 450 hours for the student.

## EXAM

### EXAMS

Name of exam	Cyber-Physical Systems
Type of exam	Oral exam based on a project Oral examination with external examiner based on a presentation of the project report.
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	Cyber-fysiske systemer
Module code	N-AIE-B5-2A
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	<a href="#">Matthias Mandø</a>
Time allocation for external examiners	B

### ORGANISATION

Education owner	Bachelor of Science (BSc) in Engineering (Applied Industrial Electronics)
Study Board	Study Board of Build, Energy, Electronics and Mechanics in Esbjerg
Department	Department of Energy
Faculty	The Faculty of Engineering and Science



# CYBER PHYSICAL SYSTEMS DESIGN AND PROGRAMMING

**2023/2024**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module is based on knowledge achieved in the modules Real-time systems and programming languages, Modelling and simulation, Data structures and algorithms, Fundamental control theory.

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

- Have knowledge about the main concepts used in cyber physical systems (CPS)
- Have knowledge about design methodologies for CPS
- Have knowledge about modern ARM processors and architectures used in CPS
- Have knowledge about operating systems concepts, concurrency, state machines and communication protocols
- Have knowledge about modern intelligent sensors and actuators used in CPS
- Have knowledge about publisher-subscriber programming model for distributed tasks and meta operating systems such as Robot Operating System (ROS)
- Have knowledge about verification and validation methods for CPS

#### SKILLS

- Be able to design and implement CPS for applications in robotics or IoT
- Be able to apply control systems concepts on the design of CPS
- Be able to apply continuous time models in designing CPS

#### COMPETENCES

- Independently develop and evaluate a CPS solution to a practical problem in robotics or IoT
- Independently analyse a problem application domain and design a CPS based solution to it
- Have a fundamental understanding of the techniques used in CPS

### TYPE OF INSTRUCTION

Lectures with exercises, possibly supplemented with e-learning as stated in § 17 in the BSc curriculum and §18 in the BE curriculum.

### EXTENT AND EXPECTED WORKLOAD

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

## EXAM

### EXAMS

Name of exam	Cyber Physical Systems Design and 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	Cyberfysisk systemdesign og programmering
Module code	N-AIE-B5-3
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	<a href="#">Daniel Ortiz Arroyo</a>

## ORGANISATION

Education owner	Bachelor of Science (BSc) in Engineering (Applied Industrial Electronics)
Study Board	Study Board of Build, Energy, Electronics and Mechanics in Esbjerg
Department	Department of Energy
Faculty	The Faculty of Engineering and Science

# INTRODUCTION TO ARTIFICIAL INTELLIGENCE

**2023/2024**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module is based on knowledge achieved in the modules Linear algebra, Calculus, Data structures and algorithms, Real-time systems and programming languages.

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

- Have knowledge about what encompasses artificial intelligence (AI) and its main applications
- Have knowledge about the basic algorithms and heuristics used for searching in graphs such as shortest path, A\* and the travelling salesman problem
- Have knowledge about optimisation techniques such as gradient based methods for convex functions and metaheuristic methods
- Have knowledge about the concepts of supervised and unsupervised machine learning techniques, about perceptron learning and multilayer perceptron learning for classification
- Have knowledge about crisp logic systems and knowledge representation
- Have knowledge about image processing and computer vision algorithms

#### SKILLS

- Be able to design and implement AI based algorithms and heuristics for searching, optimisation or knowledge representation in a modern computer language such as Python or C++
- Be able to develop computer programs using libraries to implement machine learning based systems for specific applications
- Be able to design AI based computer programs for computer vision and reasoning using 1st order logic

#### COMPETENCES

- Independently be able to apply AI to solve problems in robotics and computer vision
- Independently develop an AI based system solutions for a specific application domain
- Have a fundamental understanding of the techniques used in AI

#### TYPE OF INSTRUCTION

Lectures with exercises, possibly supplemented with e-learning as stated in § 17 in the BSc curriculum and §18 in the BE curriculum.

#### EXTENT AND EXPECTED WORKLOAD

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

## EXAM

### EXAMS

Name of exam	Introduction to Artificial Intelligence
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	Introduktion til kunstig intelligens
Module code	N-AIE-B5-4
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	<a href="#">Daniel Ortiz Arroyo</a>

### ORGANISATION

Education owner	Bachelor of Science (BSc) in Engineering (Applied Industrial Electronics)
Study Board	Study Board of Build, Energy, Electronics and Mechanics in Esbjerg
Department	Department of Energy
Faculty	The Faculty of Engineering and Science

# **BACHELOR PROJECT: AUTONOMOUS ROBOTIC SYSTEMS AND LANGUAGES**

**2023/2024**

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

The module is based on knowledge achieved in the module Real-time systems and programming languages, Modern digital control, Introduction to artificial intelligence, Cyber physical systems design and programming, Programming paradigms and translators, or similar.

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

### **LEARNING OBJECTIVES**

#### **KNOWLEDGE**

- Have knowledge about the modelling and simulation of autonomous robotic systems such as robotic manipulators or unmanned autonomous vehicle (UAV) such as drones or ground robots
- Have knowledge about mission planning, path planning, and autonomous navigation of UAVs
- Have knowledge about the design of special purpose domain specific computer languages for mission and task descriptions and planning
- Have knowledge about the use of programming paradigms to implement high level abstractions for concurrency, logical reasoning and learning
- Have knowledge about centralized and distributed control

#### **SKILLS**

- Be able to design and implement an autonomous robotic system or UAV to solve an automation problem on a specific application domain
- Be able to design both motion and actuator controllers for navigation of UAV
- Be able to design and implement trajectory and path planning or visual servoing on a robotic manipulator or UAV
- Be able to design and implement a task control system for robotic manipulators or mission control system for an UAV

#### **COMPETENCES**

- Independently propose and evaluate a robotic system solution to solve an automation problem within an application domain
- Independently be able to apply modelling, simulation and control techniques for the automation of the considered systems
- Independently propose and evaluate the architecture in software and hardware of an autonomous robotic system

#### **TYPE OF INSTRUCTION**

Problem based and project organised work in project groups focused on self-critical reflection and proactive participation. The project may be discipline-oriented, interdisciplinary or part of a multidisciplinary project depending on project choice.

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

Since it is a 15 ECTS project module, the work load is expected to be 450 hours for the student.

## EXAM

### EXAMS

Name of exam	Bachelor Project: Autonomous Robotic Systems and Languages
Type of exam	Master's thesis/final project Oral examination with external examiner based on a presentation of the project report.
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	Bachelorprojekt: Autonome robotsystemer og programmeringssprog
Module code	N-AIE-B6-6
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	<a href="#">Daniel Ortiz Arroyo</a>

### ORGANISATION

Education owner	Bachelor of Science (BSc) in Engineering (Applied Industrial Electronics)
Study Board	Study Board of Build, Energy, Electronics and Mechanics in Esbjerg
Department	Department of Energy
Faculty	The Faculty of Engineering and Science

# PROGRAMMING PARADIGMS AND TRANSLATORS

**2023/2024**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module is based on knowledge achieved in the modules Real-time systems and programming languages, Data structures and algorithms, Introduction to artificial intelligence, or similar.

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

- Have knowledge about the fundamental programming paradigms used in artificial intelligence and robotics such as distributed computing, object oriented, functional and logic paradigms
- Have knowledge on the application of distributed, functional, object oriented and logical paradigms in robotics and AI
- Have knowledge on the process of building compilers and interpreters
- Have knowledge on automata theory, parsing, lexical and semantic analysis and code generation

#### SKILLS

- Be able to develop distributed computing systems using libraries
- Be able to design algorithms and heuristics used in robotics and AI using the object oriented, functional or logic paradigm
- Be able to design interpreters or compilers for simple domain specific languages

#### COMPETENCES

- Independently be able to apply distributed computing to implement robotic systems consisting of multiple computing devices
- Independently be able to evaluate which of the programming paradigms should be used to building robotic systems and AI based applications
- Independently develop a parser, interpreter or compiler using libraries
- Have a fundamental understanding on computer languages, programming paradigms and its applications

#### TYPE OF INSTRUCTION

Lectures with exercises, possibly supplemented with e-learning as stated in § 17 in the BSc curriculum and §18 in the BE curriculum.

#### EXTENT AND EXPECTED WORKLOAD

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

## EXAM

### EXAMS

Name of exam	Programming Paradigms and Translators
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	Programmeringsparadigmer og oversættere
Module code	N-AIE-B6-7
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	<a href="#">Matthias Mandø</a>

## ORGANISATION

Education owner	Bachelor of Science (BSc) in Engineering (Applied Industrial Electronics)
Study Board	Study Board of Build, Energy, Electronics and Mechanics in Esbjerg
Department	Department of Energy
Faculty	The Faculty of Engineering and Science