AALBORG UNIVERSITET

# STUDIEORDNING FOR BACHELORUDDANNELSEN (BSC) I ANVENDT INDUSTRIEL ELEKTRONIK 2020

BACHELOR (BSC) I TEKNISK VIDENSKAB
ESBJERG

MODULER SOM INDGÅR I STUDIEORDNINGEN

# INDHOLDSFORTEGNELSE

# BASIC ELECTRONIC SYSTEMS

# 2020/2021

## 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 documented in a P0 report including also a process analysis for the P0 period. The P0 report is presented in a P0 status and presentation seminar 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.

## EXAMS

| | |
|---|---|
| Name of exam | Basic Electronic Systems |
| Type of exam | Oral exam based on a project<br>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 | Dil Muhammad Akbar Hussain |

# ORGANISATION

| | |
|---|---|
| Study Board | Study Board of Energy |
| Department | Department of Energy Technology |
| Faculty | Faculty of Engineering and Science |

# CALCULUS

# 2020/2021

## 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 137,5 hours for the student.

## EXAM

### EXAMS

| | |
|---|---|
| Name of exam | Calculus |
| Type of exam | Written or oral exam |
| ECTS | 5 |
| Permitted aids | |
| 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 | Lisbeth Fajstrup |

## ORGANISATION

| | |
|---|---|
| Study Board | Study Board of Mathematical Sciences |
| Department | Department of Mathematical Sciences |
| Faculty | Faculty of Engineering and Science |

# ENERGISYSTEMERS GRUNDLÆGGENDE FYSIK OG OPBYGNING

# 2020/2021

## 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 ARBEJDSINDSATS

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 |

## 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 | Tanmay Chaturvedi,<br>Amin Hajizadeh,<br>Jens Bo Holm-Nielsen |

## ORGANISATION

| | |
|---|---|
| Studienævn | Studienævn for Energi |
| Institut | Institut for Energi teknik |
| Fakultet | Det Ingeniør- og Naturvidenskabelige Fakultet |

# PROBLEMBASERET LÆRING

# 2020/2021

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

### LÆRINGSMÅL

#### VIDEN

- centrale tilgange, begreber og teknikker i problembaseret læring
- forskellige problemtyper, projekttyper 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, projektorganiseret 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 |
| Undervisningssprog | Engelsk |
| Tomplads | Ja |
| Undervisningssted | Campus Esbjerg |
| Modulansvarlig | Jette Egelund Holgaard |

## ORGANISATION

| | |
|---|---|
| Studienævn | Studienævn for Planlægning og Landinspektøruddannelsen |
| Institut | Institut for Planlægning |
| Fakultet | Det Tekniske Fakultet for IT og Design |

# MICROPROCESSOR BASED SYSTEMS

# 2020/2021

## PREREQUISITE/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<br>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 | Dil Muhammad Akbar Hussain |

## ORGANISATION

| | |
|---|---|
| Study Board | Study Board of Energy |
| Department | Department of Energy Technology |
| Faculty | Faculty of Engineering and Science |

# ELEKTRISKE GRUNDFAG

# 2020/2021

## 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 kredsløbsteknikken 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 ARBEJDSINDSATS

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.

## PRØVER

| | |
|---|---|
| Prøvens navn | Elektriske grundfag |
| Prøveform | Skriftlig<br>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-EN-B2-2AZ |
| Modultype | Kursus |
| Varighed | 1 semester |
| Semester | Forår |
| ECTS | 5 |
| Undervisningssprog | Engelsk |
| Tomplads | Ja |
| Undervisningssted | Campus Aalborg, Campus Esbjerg |
| Modulansvarlig | Filipe Miguel Faria da Silva,<br>Mohsen N. Soltani |

# ORGANISATION

| | |
|---|---|
| Studienævn | Studienævn for Energi |
| Institut | Institut for Energi teknik |
| Fakultet | Det Ingeniør- og Naturvidenskabelige Fakultet |

# REALTIDSSYSTEMER OG PROGRAMMERINGSSPROG

# 2020/2021

## FORUDSÆTNINGER/ANBEFALEDE FORUDSÆTNINGER FOR AT DELTAGE I MODULET

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

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

### LÆRINGSMÅL

#### VIDEN

- Have viden om talsystemer (decimal, binær, hexadecimal), basale aritmetiske operatorer og repræsentation af hel- og decimaltal
- Have viden om basale 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 udviklingsmiljø til programudvikling i *C* og til fejlfinding
- Have grundlæggende forståelse for 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 kvadratursignaler
- Have kendskab til udvikling/fejlfinding af *C*-programmer til mikrokontrollere anvendt i realtidsapplikationer med både interrupt service rutiner og ikke-tidskritiske rutiner
- Have kendskab til tidsdiskret implementering af filtre, regulatorer og puls-breddemodulatorer i mikrokontrollere
- Have kendskab til metoder til grafisk programmering
- Have kendskab til programmering vha. dataflowteknikker ved brug at 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 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 interfacekredsløb skal anvendes
- Være i stand til at interface en 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 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-learning og miniprojekt.

### OMFANG OG FORVENTET ARBEJDSINDSATS

Kursusmodulets omfang er 10 ECTS svarende til 300 timers studieindsats.

## EKSAMEN

### PRØVER

| | |
|---|---|
| Prøvens navn | Realtidssystemer og programmeringssprog |
| Prøveform | Aktiv deltagelse/løbende evaluering<br>Undervisningsdeltagelse med mindst 80% fremmøde samt godkendelse af miniprojekt, der kan udarbejdes gruppevis. Omfang ca. 10 sider (max. 2800 karakterer pr. side).<br>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-B4-4AZ |
| Modultype | Kursus |
| Varighed | 1 semester |
| Semester | Forår |
| ECTS | 10 |
| Undervisningssprog | Engelsk |
| Tomplads | Ja |
| Undervisningssted | Campus Aalborg, Campus Esbjerg |
| Modulansvarlig | Lajos Török |

## ORGANISATION

| | |
|---|---|
| Studienævn | Studienævn for Energi |
| Institut | Institut for Energi teknik |
| Fakultet | Det Ingeniør- og Naturvidenskabelige Fakultet |

# LINEAR ALGEBRA

# 2020/2021

## PREREQUISITE/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 $R^n$
- 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 matrice.
- 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 137,5 hours for the student.

## EXAM

### EXAMS

| | |
|---|---|
| Name of exam | Linear Algebra |
| Type of exam | Written or oral exam |
| ECTS | 5 |
| Assessment | 7-point grading scale |
| Type of grading | Internal examination |

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

## FACTS ABOUT THE MODULE

| | |
|---|---|
| Danish title | Lineær algebra |
| Module code | 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 | Lisbeth Fajstrup |

## ORGANISATION

| | |
|---|---|
| Study Board | Study Board of Mathematical Sciences |
| Department | Department of Mathematical Sciences |
| Faculty | Faculty of Engineering and Science |

# INSTRUMENTATION

# 2020/2021

## PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

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

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### 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 and demonstration in laboratory

#### COMPETENCES

- Be able to design and implement instrumentation for systems based on demanded specifications
- Independently analyse and implement suitable signal processing algorithms
- Have a fundamental understanding of analogue filters, signal conditioning, data acquisition
- Be able to implement and test the developed system with the purpose of verifying the hypothesis, as well as draw conclusions based on the achieved result.
- 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<br>Oral examination with external adjudicator based on a presentation seminar and 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 | Instrumentering |
| Module code | N-AIE-B3-1A |
| 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 | Dil Muhammad Akbar Hussain |

# ORGANISATION

| | |
|---|---|
| Study Board | Study Board of Energy |
| Department | Department of Energy Technology |
| Faculty | Faculty of Engineering and Science |

# AC-KREDSLØBSTEORI

# 2020/2021

## FORUDSÆTNINGER/ANBEFALEDE FORUDSÆTNINGER FOR AT DELTAGE I MODULET

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

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

### 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. supplering med e-learnings aktiviteter.

### OMFANG OG FORVENTET ARBEJDSINDSATS

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-B3-2AZ |
| Modultype | Kursus |
| Varighed | 1 semester |
| Semester | Efterår |
| ECTS | 5 |
| Undervisningssprog | Engelsk |
| Tomplads | Ja |
| Undervisningssted | Campus Aalborg, Campus Esbjerg |
| Modulansvarlig | Amin Hajizadeh |

# ORGANISATION

| | |
|---|---|
| Studienævn | Studienævn for Energi |
| Institut | Institut for Energi teknik |
| Fakultet | Det Ingeniør- og Naturvidenskabelige Fakultet |

# ANVENDT INGENIØRMATEMATIK

# 2020/2021

## FORUDSÆTNINGER/ANBEFALEDE 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 differentialligninger 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, kurveuafhængighed 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 differentialligninger
  - Foldning og integralligninger
  - Differentiation og integration af transformerede systemer med ordinære differentialligninger

- 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 (individuelt og i grupper)
- lærerfeedback
- faglig refleksion
- porteføljearbejde
- laboratoriearbejde
- e-learning

### OMFANG OG FORVENTET ARBEJDSINDSATS

Kursusmodulets omfang er 5 ECTS svarende til 150 timers studieindsats.

## EKSAMEN

### PRØVER

| | |
|---|---|
| Prøvens navn | Anvendt ingeniørmatematik |
| Prøveform | Skriftlig<br>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 | N-EN-B3-3AZ |
| Modultype | Kursus |
| Varighed | 1 semester |
| Semester | Efterår |
| ECTS | 5 |
| Undervisningssprog | Engelsk |
| Tomplads | Ja |
| Undervisningssted | Campus Aalborg, Campus Esbjerg |
| Modulansvarlig | Morten Nielsen,<br>Anne Marie Svane |

# ORGANISATION

| | |
|---|---|
| Studienævn | Studienævn for Energi |
| Institut | Institut for Energi teknik |
| Fakultet | Det Ingeniør- og Naturvidenskabelige Fakultet |

# SIGNAL PROCESSING

# 2020/2021

## PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

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

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

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

#### SKILLS

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

#### COMPETENCES

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

### TYPE OF INSTRUCTION

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 | Signal Processing |
| 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 | Signalbehandling |
| Module code | N-AIE-B3-2A |
| 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 | Petar Durdevic |

## ORGANISATION

| | |
|---|---|
| Study Board | Study Board of Energy |
| Department | Department of Energy Technology |
| Faculty | Faculty of Engineering and Science |

# CONTROL SYSTEMS

# 2020/2021

## PREREQUISITE/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<br>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 | Tamas Kerekes |

# ORGANISATION

| | |
|---|---|
| Study Board | Study Board of Energy |
| Department | Department of Energy Technology |
| Faculty | Faculty of Engineering and Science |

# GRUNDLÆGGENDE REGULERING

# 2020/2021

## FORUDSÆTNINGER/ANBEFALEDE FORUDSÆTNINGER FOR AT DELTAGE I MODULET

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

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

### 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 (individuelt og i grupper)
- lærerfeedback
- faglig refleksion

- porteføljearbejde
- laboratoriearbejde
- e-learning

### OMFANG OG FORVENTET ARBEJDSINDSATS

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 | Henrik C. Pedersen,<br>Zhenyu Yang |

## ORGANISATION

| | |
|---|---|
| Studienævn | Studienævn for Energi |
| Institut | Institut for Energi teknik |
| Fakultet | Det Ingeniør- og Naturvidenskabelige Fakultet |

# MODELLING AND SIMULATION

# 2020/2021

## PREREQUISITE/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 | Birgitte Bak-Jensen |

## ORGANISATION

| | |
|---|---|
| Study Board | Study Board of Energy |
| Department | Department of Energy Technology |
| Faculty | Faculty of Engineering and Science |

# EFFEKTELEKTRONIK

# 2020/2021

## FORUDSÆTNINGER/ANBEFALEDE 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 (individuelt og i grupper)
- lærerfeedback
- faglig refleksion
- porteføljearbejde
- laboratoriearbejde
- evt. e-learning

### OMFANG OG FORVENTET ARBEJDSINDSATS

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 | Ekstern prøve |
| Vurderingskriterier | Vurderingskriterierne er angivet i Universitetets eksamensordning |

# FAKTA OM MODULET

| | |
|---|---|
| Engelsk titel | Power Electronics |
| Modulkode | N-EN-BE6-4A |
| Modultype | Kursus |
| Varighed | 1 semester |
| Semester | Forår |
| ECTS | 5 |
| Undervisningssprog | Engelsk |
| Tomplads | Ja |
| Undervisningssted | Campus Esbjerg |
| Modulansvarlig | Amin Hajizadeh |

# ORGANISATION

| | |
|---|---|
| Studienævn | Studienævn for Energi |
| Institut | Institut for Energi teknik |
| Fakultet | Det Ingeniør- og Naturvidenskabelige Fakultet |

# MODERNE DIGITAL REGULERING

# 2020/2021

## FORUDSÆTNINGER/ANBEFALEDE FORUDSÆTNINGER FOR AT DELTAGE I MODULET

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

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

### LÆRINGSMÅL

#### VIDEN

- Have viden om 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 signaler
- Have viden om metoder til analyse af diskret-tidssignaler og -systemer (*Z*-transformation)
- Have viden om metoder til design af diskrettids-regulatorer
- Have viden om metoder til diskretisering af tidskontinuert regulator

#### FÆRDIGHEDER

- Kunne modellere tidskontinuerte lineære dynamiske systemer på tilstandsform
- 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
- Kunne opstille performancekrav til et lukket-sløjfe system og kunne udvælge diskrettids-regulatorstruktur
- Kunne designe diskretids-regulator direkte i *z*-domænet
- Kunne anvende metoder til diskretisering af tidskontinuert regulator og være i stand til at vurdere resultatets anvendelighed
- Have forståelse for den praktiske implementering af tidsdiskrete regulatorer

#### KOMPETENCER

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

### OMFANG OG FORVENTET ARBEJDSINDSATS

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-BE5-2A |
| Modultype | Kursus |
| Varighed | 1 semester |
| Semester | Efterår |
| ECTS | 5 |
| Undervisningssprog | Engelsk |
| Tomplads | Ja |
| Undervisningssted | Campus Esbjerg |
| Modulansvarlig | Mohsen N. Soltani |

## ORGANISATION

| | |
|---|---|
| Studienævn | Studienævn for Energi |
| Institut | Institut for Energi teknik |
| Fakultet | Det Ingeniør- og Naturvidenskabelige Fakultet |

# ELEKTRISKE MASKINER

# 2020/2021

## FORUDSÆTNINGER/ANBEFALEDE FORUDSÆTNINGER FOR AT DELTAGE I MODULET

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

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

### 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 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 ækvivalentdiagramsmodellerne
- 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-learning.

### OMFANG OG FORVENTET ARBEJDSINDSATS

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-B5-5A |
| Modultype | Kursus |
| Varighed | 1 semester |
| Semester | Efterår |
| ECTS | 5 |
| Undervisningssprog | Engelsk |
| Tomplads | Ja |
| Undervisningssted | Campus Aalborg, Campus Esbjerg |
| Modulansvarlig | Kaiyuan Lu,<br>Dong Wang,<br>Sanjeevikumar Padmanaban |

# ORGANISATION

| | |
|---|---|
| Studienævn | Studienævn for Energi |
| Institut | Institut for Energi teknik |
| Fakultet | Det Ingeniør- og Naturvidenskabelige Fakultet |

# NUMERISKE METODER

# 2020/2021

## FORUDSÆTNINGER/ANBEFALEDE FORUDSÆTNINGER FOR AT DELTAGE I MODULET

Modulet bygger videre på viden opnået i ”Anvendt ingeniørmatematik”.

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

### LÆRINGSMÅL

#### VIDEN

- Skal have forståelse for løsning af partielle differentialligninger med analytiske metoder.
- Skal have forståelse for forskellige numeriske metoder.
- Skal have forståelse for finite difference, finite volume og finite element metoden.

#### FÆRDIGHEDER

- Skal kunne anvende analytiske metoder til løsning af partielle differentialligninger, herunder
  - Separationsmetoden og D’Alemberts princip.
- Skal kunne anvende numeriske metoder til løsning af matematiske problemer, herunder:
  - Lineære ligningssystemer, Gauss elimination, faktoriseringsmetoder, iterativ løsning af lineære ligningssystemer (bl.a. Gauss-Seidel), dårligt konditionerede lineære ligningssystemer, Matrix egenværdiproblemer, løsning af ikke-lineære ligninger, interpolation, splines, numerisk løsning af bestemt integrale, numerisk løsning af første ordens differentialligninger og numerisk løsning af anden ordens differentialligninger.
- Skal kunne anvende finite difference metoden til løsning af partielle differentialligninger, herunder
  - Differenstilnærmelser, elliptiske ligninger, Dirichlet og Neumann randværdier, parabolske ligninger, eksplicitte og implicitte metoder, Theta-metoden og hyperbolske ligninger.
  - Relationen til finite volume metoden.
- Skal have forståelse for finite element metoden til løsning af partielle differentialligninger.

#### 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. §17 i bachelorstudieordningen og §18 i diplomingeniørstudieordningen.

### OMFANG OG FORVENTET ARBEJDSINDSATS

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

# EKSAMEN

## PRØVER

| | |
|---|---|
| Prøvens navn | Numeriske metoder |
| Prøveform | 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-B5-3 |
| Modultype | Kursus |
| Varighed | 1 semester |
| Semester | Efterår |
| ECTS | 5 |
| Undervisningssprog | Engelsk |
| Tomplads | Ja |
| Undervisningssted | Campus Aalborg, Campus Esbjerg |
| Modulansvarlig | Erik Lund,<br>Thomas Condra |

# ORGANISATION

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

# MEKANIK

# 2020/2021

## FORUDSÆTNINGER/ANBEFALEDE FORUDSÆTNINGER FOR AT DELTAGE I MODULET

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

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

### 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 analyse bjælkeelementer mht. tøjning og spænding under forskellige belastningssituationer
- Skal kunne analyser 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 (individuelt og i grupper)
- lærerfeedback
- faglig refleksion
- porteføljearbejde
- laboratoriearbejde
- e-learning

### OMFANG OG FORVENTET ARBEJDSINDSATS

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 | N-EN-B4-3AZ |
| Modultype | Kursus |
| Varighed | 1 semester |
| Semester | Forår |
| ECTS | 5 |
| Undervisningssprog | Engelsk |
| Tomplads | Ja |
| Undervisningssted | Campus Aalborg, Campus Esbjerg |
| Modulansvarlig | Jørgen Asbøll Kepler |

## ORGANISATION

| | |
|---|---|
| Studienævn | Studienævn for Energi |
| Institut | Institut for Energi teknik |
| Fakultet | Det Ingeniør- og Naturvidenskabelige Fakultet |

# MODELLING AND CONTROL OF ROBOT MANIPULATOR

# 2020/2021

## PREREQUISITE/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 | Petar Durdevic |

# ORGANISATION

| | |
|---|---|
| Study Board | Study Board of Energy |
| Department | Department of Energy Technology |
| Faculty | Faculty of Engineering and Science |

# TEST AND VALIDATION INCLUDING SYSTEM SET-UP AND UNDERSTANDING

# 2020/2021

## PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

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

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### 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 vise versa
- Have knowledge about what to measure and with which precision, this includes knowledge about
    - Different measurement techniques to be applied
    - Planning and documentation
    - Accuracy
        - analogue versus digital measurements and the combination hereof
    - What affects the accuracy and the resolution of measured signals
- Have knowledge about how to detect signals in noise
    - Mean values and standard deviation
    - Noise and interference, coupling mechanisms

#### SKILLS

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

#### COMPETENCES

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

### TYPE OF INSTRUCTION

Lectures, laboratory work and practical exercises.

### 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-B6-4 |
| 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 | Birgitte Bak-Jensen |

# ORGANISATION

| | |
|---|---|
| Study Board | Study Board of Energy |
| Department | Department of Energy Technology |
| Faculty | Faculty of Engineering and Science |

# AUTOMATION INCLUDING POWER ELECTRONICS

# 2020/2021

## PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

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

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### 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 a business case for the automated power electronic device or system

#### SKILLS

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

#### COMPETENCES

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

### TYPE OF INSTRUCTION

Problem based and project oriented work in project groups.

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

### 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<br>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 | Automatisering med anvendt effektelektronik |
| Module code | N-AIE-B5-1 |
| 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 | Simon Pedersen,<br>Sanjeevikumar Padmanaban |
| Time allocation for external examiners | B |

## ORGANISATION

| | |
|---|---|
| Study Board | Study Board of Energy |
| Department | Department of Energy Technology |
| Faculty | Faculty of Engineering and Science |

# CYBER-PHYSICAL SYSTEMS

# 2020/2021

## PREREQUISITE/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 and software 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 a 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 and industrial platform software’s.
- 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<br>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 | Simon Pedersen,<br>Sanjeevikumar Padmanaban |
| Time allocation for external examiners | B |

# ORGANISATION

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|---|---|
| Study Board | Study Board of Energy |
| Department | Department of Energy Technology |
| Faculty | Faculty of Engineering and Science |

# BSC PROJECT: POWER ELECTRONICS AND ELECTRICAL MACHINES (ELECTIVE)

# 2020/2021

## PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

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

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

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

#### SKILLS

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

#### COMPETENCES

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

### TYPE OF INSTRUCTION

Problem based and project 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 | Power Electronics and Electrical Machines (elective) |
| Type of exam | Master's thesis/final project<br>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 |

# ADDITIONAL INFORMATION

The student can choose from two bachelor-projects:*Power Electronics and Electrical Machines* or *Modelling and Control of Robotic Systems*.

# FACTS ABOUT THE MODULE

| | |
|---|---|
| Danish title | BSc projekt: Effektelektronik og elektriske maskiner (valgfag) |
| Module code | N-AIE-B6-1A |
| 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 | Daniel Ortiz Arroyo |

# ORGANISATION

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|---|---|
| Study Board | Study Board of Energy |
| Department | Department of Energy Technology |
| Faculty | Faculty of Engineering and Science |

# BSC PROJECT: MODELLING AND CONTROL OF ROBOTIC SYSTEMS (ELECTIVE)

# 2020/2021

## PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module is based on knowledge achieved in the modules Modeling and control of robotic systems, Modelling and simulation, Mechanics, Real time systems and Modern digital control or similar.

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

- Have knowledge about robotic systems including its modelling, simulation, control and implementation
- Have development-based knowledge and understanding within the profession and the discipline's practice and applied theories and methods
- Be able to understand scientific methods and theories compared to the semester theme and see the project in a larger context

#### SKILLS

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

#### COMPETENCES

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

### TYPE OF INSTRUCTION

Problem based and project 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 | Modelling and Control of Robotic Systems (elective) |
| Type of exam | Master's thesis/final project<br>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 |

# ADDITIONAL INFORMATION

The student can choose from two bachelor-projects:*Power Electronics and Electrical Machines* or *Modelling and Control of Robotic Systems*.

# FACTS ABOUT THE MODULE

| | |
|---|---|
| Danish title | BSc projekt: Modellering og regulering af robotsystemer (valgfag) |
| Module code | N-AIE-B6-2A |
| 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 | Daniel Ortiz Arroyo |
| Time allocation for external examiners | C |

# ORGANISATION

| | |
|---|---|
| Study Board | Study Board of Energy |
| Department | Department of Energy Technology |
| Faculty | Faculty of Engineering and Science |