Module description S4
Mechatronics

Exchange program spring 2019-2020

Rev	Date	Description
1.0	2019 09 20	Baseline exchange program

Schema of all module’s per quarter

Exchange program Mechatronics 2019-2020							
Q3				**Q4**			
Module name	**Code**	**EC**	**obligatory**	**Module name**	**Code**	**EC**	**obligatory**
Deformations 4	DEF4	2		Design Principles 4	DPR4	3	
Control Engineering 4A	CEN4A	2		Control Engineering 4B	CEN4B	3	
Advanced Electronic Circuits 2	AEC2	3		Sensors 4	SNS4	3	
Sequential Digital Design 4	SDD4	3		Object Oriented Programming 4	SDD4	3	
Mathematics 4	MAT4	2		Project 7	PRJ7	3	yes
Project 6	PRJ6	3	yes				
	Total	**15**			Total	**15**	

Important

- The resit of written exams from Q4 takes place in September. In case of resit, an appointment with home University will be made.

Module : Control Engineering 4A
Code : MCACEN4A
Size : 2 EC (56 hours)

Course description

- The student of mechatronics must have knowledge and understanding of the systematic way in which a control technical problem must be tackled. After the problem analysis has taken place, he continues with the modelling and the controller design. The simulation (Matlab / Simulink) plays a major role in these last two steps.
- In module CEN4A the student
  - gains experience with modelling and the different ways in which a model can be described;
  - gains insight into various types of processes and basic systems;
  - learns about effects of feedback;
  - learns how to design a controller for a linear process based on predetermined requirements;
- Simulation with Matlab / Simulink is an important part of this module and many practical exercises are done with Matlab / Simulink.
- The resit of this practicum takes place in Q4.
- The written theory test takes place at the end of the period and lasts 100 minutes.

Required prior knowledge

- The student should have knowledge of:
  - Apply the theory, use matrices (of which vectors) and scalars in the MATLAB environment.
  - Make and use pre-built functions and scripts in the MATLAB environment.
  - Write `if then else'-loops, `for'-loops and(or) `while'-loops in the MATLAB environment.
  - Make various plots of continuous-time and discrete-time signals in the MATLAB environment.
  - Concisely document found results from simulations and calculations done in the MATLAB environment.
- The student is expected to be familiar with the following math topics:
  - Differentiating and integrating simple functions;
  - Solving simple linear differential equations with constant cofficinths;
  - Vectors;
  - Complex numbers;

Learning materials

Feedback Control of Dynamic Systems, Global edition 7e Gene, F.-e.a.Pearson 9781292068909

Module : Control Engineering 4B
Code : MCACEN4B
Size : 3 EC (84 hours)

Course description

- This course is a follow up of Control Engineering 4A.
- The practical exercises are done with Matlab / Simulink in addition to gain experimental knowledge with the use of Fontys equipment.
- The completion of this practical is a final report.
- The resit of this practicum takes place in Q4 before the teachers' summer vacation starts.
- The presence is compulsory for the practical parts with the use of Fontys equipment.

Required prior knowledge

- The student should have knowledge of;
  - Apply the theory, use matrices (of which vectors) and scalars in the MATLAB environment.
  - Make and use pre-built functions and scripts in the MATLAB environment.
  - Write `if then else'-loops, `for'-loops and(or) `while'-loops in the MATLAB environment.
  - Make various plots of continuous-time and discrete-time signals in the MATLAB environment.
  - Concisely document found results from simulations and calculations done in the MATLAB environment.
- The theory and practice of MCACEN4A;
- The student is expected to be familiar with the following math topics:
  - Differentiating and integrating simple functions;
  - Solving simple linear differential equations with constant cofficinths;
  - Vectors;
  - Complex numbers;

Learning materials

Feedback Control of Dynamic Systems, Global edition 7e Gene, F.-e.a.Pearson 9781292068909

Module : Deformations 4
Code : MCADEF4
Size : 2 EC (56 hours)

Course description

Mechanics is a part of physics that deals with balance and movement of objects under the influence of the forces acting on them. It consists of different parts, which are applicable in different situations. Force often plays an important role in products and constructions. This can be external and internal force. With calculations it can be demonstrated whether these forces are permissible so that a product or construction does not fail. In this module the student gains insight into the theory of tensions and distortions. The student gains insight into the matter during practical lessons where physical behaviour of materials under load is explained.

Required prior knowledge

- Basic knowledge of math skills, differentiation and integration.

Learning materials

Mechanics of Materials, R.C. Hibbeler, 10th edition, Pearson Global Edition, ISBN 10: 1-292-17820-5

Module : Design Principles 4
Code : MCADPR4
Size : 3 EC (84 hours)

Course description

The course Design Principles for precision mechanisms deals with the mechanism (mechanical part) of driven (precision) systems. To achieve precision systems, a high degree of predictability and reproducibility is required.

In this module tools / a way of thinking will be given to realize constructions that meet the core qualities of predictability and reproducibility of the system. These core qualities are achieved by, among other things, constructing statically undetermined, play-free, light and stiff constructions.

The tools do not relate so much to calculations (you must of course be able to do that), but more to apply the theory, using a way of thinking (principle). A way of thinking that will provide insight into the operation and physical background of structures for driven (precision) systems.

Learning goals

- Determine the (internal) degrees of freedom (amount and direction) of constructions and construction elements and assess for static determination Design a structure so that it is statically determined.
- Assess and design constructions and construction elements for stiffness Make stiffness calculations of constructions and construction elements.
- Apply and evaluate flexure mechanisms (among others by calculations) in mechanical constructions Assess and optimize constructions with respect to backlash.

Required prior knowledge

The module DPR4 is an overarching mechanical course. Therefore the student should have knowledge of: Statics and Mechanics, Dynamics and Strength of Materials.

Learning materials

Design Principles for precision mechanisms, H. Soemers, T-Point Print Vof, ISBN 9789036531030

Module : Mathematics 4
Code : MCAMAT4
Size : 2 EC (56 hours)

Course description

The purpose of this module is to lay a good foundation in mathematical skills around the two subjects (1) statistics and (2) matrix calculation.

Matrix calculation and statistics are used in Mechatronics to handle large amounts of data. The two disciplines are used in control engineering, mechanical engineering and electrical engineering where it concerns large, more complex models and the interpretation and processing of (measurement) data. The matrix calculation course provides the theoretical basis for programming in Matlab.

Learning goals

- Add, subtract and multiply matrices. Calculate the transposed, inverse and determinant of a matrix.
- Convert equations to matrices and (if possible) resolve them with the inverse matrix, the Gaussian elimination method and / or the Cramer rule.
- Determine the eigenvalues and eigenvectors of a square matrix.
- Create transformation matrices
- Calculate the expected value, variance and standard deviation.
- Explain the different types of probability distribution and their properties: general, binomial, Poisson, normal, continuous, discreet and continuous approach.
- In a given situation, recognize the type of probability distribution and calculate the probability of the requested situation.
- Combine stochastic variables and thereby solve so-called fitting problems.
- Determine the size of a sample based on a desired confidence interval.

How is the course completed? Written exam with largely open questions. The duration of the exam is 100 minutes

Required prior knowledge

No specific prior knowledge required

Learning materials

Materials on N@tschool

Module : Object Oriented Programming 4
Code : MCAOOP4
Size : 3 EC (84 hours)

Course description

During this course students learn to program with Python and they learn the basic concepts of Object Oriented Programming (OOP). This course only consists of practical hours in which the teacher will coach the students in their work. As final project of this course students have to invent their own application and implement it using python. Students are free as long as the final project satisfies a number of criteria.

Students have to deliver a portfolio containing small explanations and test results of the assignments given to them in week 1 to week 4, plus description, class diagram and code of the final project. In the final project students have to make a program containing communication with another device, a gui and an object oriented design. Furthermore the outcome of the final project is evaluated by a demonstration and answering questions. Students pass with a grade 5.5 or higher. The quality of the final project is taken into account into the grading.

Furthermore, attendance of classes is required (at least 10 out of 14).Students are allowed to work individually or as a group of 2 students. Groups are established during the first class.Note: If a student drops out during the practical the other team member is not allowed to form a new group with a third person but has to finish the practical by himself.

Learning goals

- understand the difference between imperative programming and object oriented programming and between compliable code and scripted code
- understand the differences between programming constructs in C and in Python and program basic constructs in python (like variable assignment, functions, loops, conditions)
- analysing a UML class diagram and based on this diagram write the corresponding program
- find unknown open source libraries, evaluate them on usability and use them in a python program
- program a self-defined user interface in Python using TKinter
- program serial communication and TCP/IP communication in Python
- program a self-defined Python application using different classes and a logical structure

Required prior knowledge

No specific prior knowledge required

Learning materials

Python, Visual Studio Code, Some slides on n@tschool, The Internet

Module : Project 6
Code : MCAPRJ6
Size : 3 EC (84 hours)

Course description

The objective of the educational model at Engineering is to include students in the projects. Projects offer the opportunity to show that the students are competent in applying taught techniques and theory from the domain specific modules in the practical implementation. The projects are shaped in such a way that they comply with the educational objectives within the education where they are used. It is important that the student receives a sufficiently broad education therefor he/she needs to fulfil different roles within project group. Student:

- specifies and frames the assignment
- gain experience in project implementation
- learn from the group members
- deliver the product

In this way, derived from problem description in professional practice, a continuous "professional practice-driven" educational development process occurs.

Required prior knowledge

No specific prior knowledge required

Learning materials

Fontys eXPo website, N@tschool

Module : Project 7
Code : MCAPRJ7
Size : 3 EC (84 hours)

Course description

The objective of the educational model at Engineering is to include students in the projects. Projects offer the opportunity to show that the students are competent in applying taught techniques and theory from the domain specific modules in the practical implementation. The projects are shaped in such a way that they comply with the educational objectives within the education where they are used. It is important that the student receives a sufficiently broad education therefor he/she needs to fulfil different roles within project group. Student:

- specifies and frames the assignment
- gain experience in project implementation
- learn from the group members
- deliver the product

In this way, derived from problem description in professional practice, a continuous "professional practice-driven" educational development process occurs.

Required prior knowledge

No specific prior knowledge required

Learning materials

Fontys eXPo website, N@tschool

Module : Sensors 4
Code : MBSNS4
Size : 3 EC (84 hours)

Course description

The Sensors 4 module covers the most important sensors that are applied in mechatronic products. Often, there are parts that must be able to move with a certain accuracy of place and time. Actuators (motors) are required for the drive. To be able to adequately control these actuators, information is needed about position, speed, acceleration, current and voltage. Sensors provide this information and thereby give feedback to the operating system (processor). In addition to those sensors, sensors for other physical quantities are taken into consideration (including force, temperature, field strength). Most sensors require some electronics to (within a certain working area) deliver a usable signal to the control system (signal conditioning). Finally, topics are discussed that have to do with the representation and the digitization of the signal (data acquisition) and relationship with the control system.

Required prior knowledge

The student should have knowledge of

- Mesh analysis & current measuring.
- Ohms law, Kirchfoff's current and voltage law.
- Concepts voltage and current division, ideal and non-ideal voltage and current sources, dependent sources.
- Superposition, Norton and Thevenin equivalent circuits
- Capacitor, AC, Inductor, RC circuit, RL circuit, RLC circuit measurement.
- Draw, dimension or analyse a circuit with diodes based on a given circuit and/or given specifications.
- Dimension or analyse a BJT amplifier circuit (DC and/or AC), a FET circuit, an Op-Amp circuit based on a given circuit and/or given specifications.
- Explain the general concepts of magnetic circuits applied to an electromagnet (linear actuator).
- Analyse a given linear actuator, implicitly using the laws of Faraday, Hopkinson and Lorentz.
- Analyse a given idealized linear DC machine (single-conductor machine) or rotating DC machine (PM, shunt or series) and set up its electrical model, implicitly using the laws of Faraday and Lorentz.
- Draw or interpret the force-speed characteristic of a given idealized linear DC machine or the torque-speed characteristic of a given rotating DC machine.
- Analyse the thermal behaviour of an electric motor and draw or interpret the temperature curve, given all relevant (loss) parameters.

Learning materials

NI myDAQ, info on N@tschool

Module : Sequential Digital Design 4
Code : MBSDD4
Size : 3 EC (84 hours)

Course description

In the first year, a start was made on the use of digital building blocks in a mechatronic concept. In the mechatronic field, the use of a certain building block is very important, namely the FPGA. The field-programmable-gate array (FPGA) is used for processing real-time signals. For example, there can be used to control an engine with a specific controller. Because an FPGA can process parallel signals, it is also extremely suitable for image processing. In that context, the FPGA can work as an ultimate (camera) sensor.

Learning goals

- Basic principles of an FPGA;
- Setting up and validating a package of requirements;
- Describe syntax in VHDL;
- Writing a test bench;
- Choices when selecting hardware;

Required prior knowledge

The student should have knowledge of

- Operate within various systems of numeration, and execute conversions between them (binary, octal, hexadecimal, decimal)
- Design systems of combinational logic, based on requirements (logic gates, truth tables, De Morgan rules, minimization based on Karnaugh tables); design SSI and MSI circuits (multiplexers, demultiplexers, decoders)
- Design and use memory elements in digital design (flip-flops, latches, serial and parallel registers, counters)
- Design integer arithmetic and logic circuitry (addition, subtraction, multiplication, division, ALU, RALU)
- Understand and apply in applications time-related aspects of digital design (gate propagation delays, setup and hold times for flip-flops, metastability, maximum frequency for a computational block

Learning materials

Optional: Digital System Design with VHDL, M. Zwolinski, Pearson, ISBN: 0-13-039985

Module : Advanced Electronic Circuits 2
Code : MAAEC2
Size : 3 EC (84 hours)

Course description

Circuit theory is subdivided into direct current theory, alternating current theory and transient phenomena. In AEC we study the behaviour of steady states in alternating current circuits. In the AEC2 module we focus on voltages and currents that periodically change direction and magnitude. We then speak of alternating current theory. We apply the well-known problem-solving methods (mesh voltage and node current methods, the Norton's and Thévenin's theorems, and the superposition principle). Using these problem-solving methods to perform the necessary we must take account of the fact that current and voltage cannot be minimum or maximum at the same time. This is known as phase shift. We have limited ourselves to RC, RL and RLC combinations in this respect. Because making calculations using vector diagrams can be rather laborious you will also learn how to (algebraically) calculate currents and voltages in alternating current networks using complex numbers, whereby the phase relationship furthermore follows from the calculation. We will devote special attention to circuits consisting of combinations of resistors, capacitors and coils (RC, RL and RCL networks). These types of circuits exhibit frequency-dependent behaviour. This means that certain frequencies are attenuated to a greater or lesser degree. This is known as filtering and sometimes can be accompanied by voltage or current gain (resonance). In addition to applying the mesh or node methods, well-known theorems, such as the superposition theorem and Thévenin's and Norton's theorems allow us to gain faster insight into the behaviour of alternating current circuits. The AEC2 module also includes a practical. The theory, as well as the practical must be completed with a passing grade. Format and course structure The AEC2 module is spread out over 7 weeks with 2 teaching hours of 'theory' every week. In addition, starting in week 2 there will be one 'practical' every week, consisting of 2 consecutive teaching hours. The 'progress principle' may be used, which will be explained in further detail during the course.

Required prior knowledge

The student should have knowledge of

- Mesh analysis & current measuring.
- Ohms law, Kirchfoff's current and voltage law.
- Concepts voltage and current division, ideal and non-ideal voltage and current sources, dependent sources.
- Superposition, Norton and Thevenin equivalent circuits

Learning materials

NI myDAQ, info on N@tschool