Differentiations and Professional Profiles in Semester 7 Mechatronics

study year 2023-2024

The S7 program within the Mechatronics department consists of 3 differentiations that can be chosen from. A differentiation is a coherent group of modules and projects around a certain technical theme.

The differentiations that can be chosen from are carefully selected in cooperation with relevant companies and are all three highly relevant in today's working field of a Mechatronic Engineer .

You can be a Mechatronic Engineer in different roles. For that reason in the S7 program you will also choose for a professional profile. Two so-called generic modules will cover the needed knowledge and skills belonging to the professional profile.

Differentiations:	Professional Profiles:	
Advanced Motion Control	System Design and Upgrade	Applied Research
Adaptive Automation Systems	System Design and Upgrade	Applied Research
Innovation Engineering	Project Coordination	

The professional profile Project Coordination is related to the differentiation Innovation Engineering. So if you choose for Innovation Engineering, you will get the profile Project Coordination. If you choose for the profile Project Coordination, you have to do the differentiation Innovation Engineering.

A general introduction to the differentiations and professional profiles is given in this document. Every S7 program contains a project, specific modules related to the differentiation and generic modules related to the professional profile:

- The project will be chosen in the first week. You will work on the project of 10 ECTs during the whole semester.
- Depending on the chosen differentiation you will get 4 specific modules of 4 ECTs. The differentiation Innovation Engineering has only 2 modules of 4 ECTs and requires to choose two 4 ECTs modules from another differentiation, one in the first quartile and one in the second quartile. Be careful with the pre-requisite restrictions of the module while choosing those.
- Depending on the chosen professional profile you will get 2 generic modules of 2 ECTs.

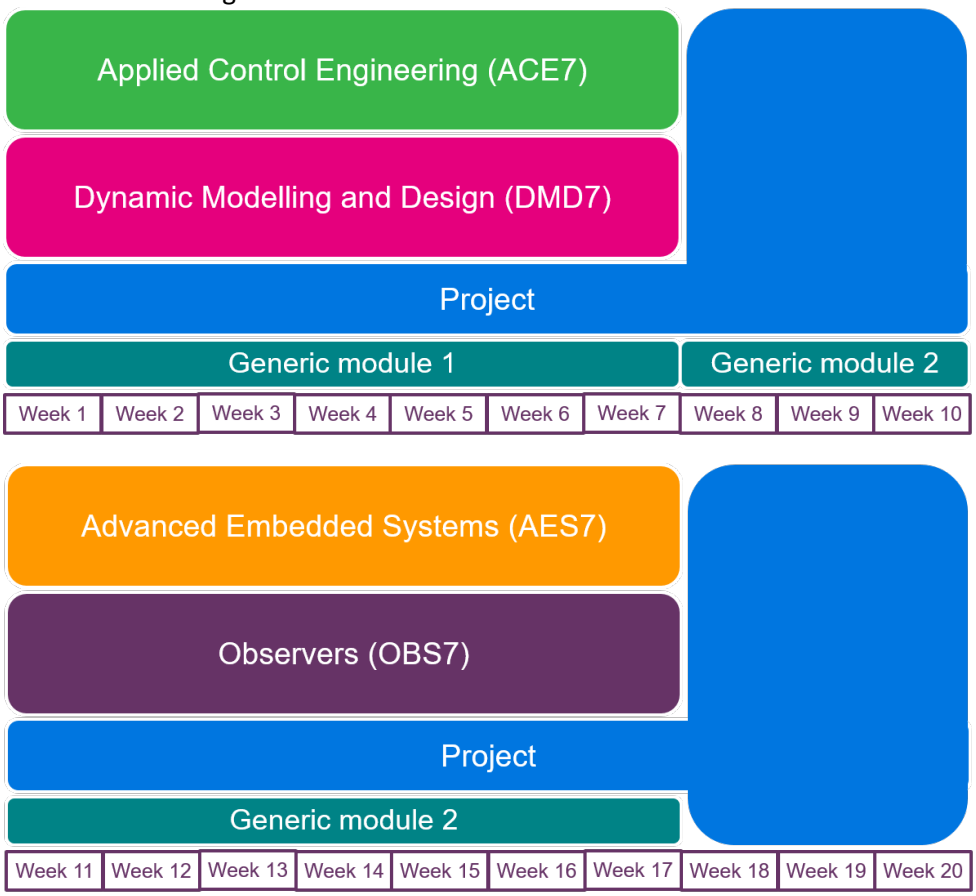
Description of the differentiations

Differentiation 1: Advanced Motion Control (AMC)

Students that choose this differentiation will focus on:

- Methods and techniques to uniformly model, analyze and control multidisciplinary real time systems.
- Create understanding about Mechatronic systems that have to use advanced hardware and software platforms to obtain maximum performance w.r.t. Motion Control.

The general overview of the differentiation is given in the figure below, a short description for the modules can be found below the figure.

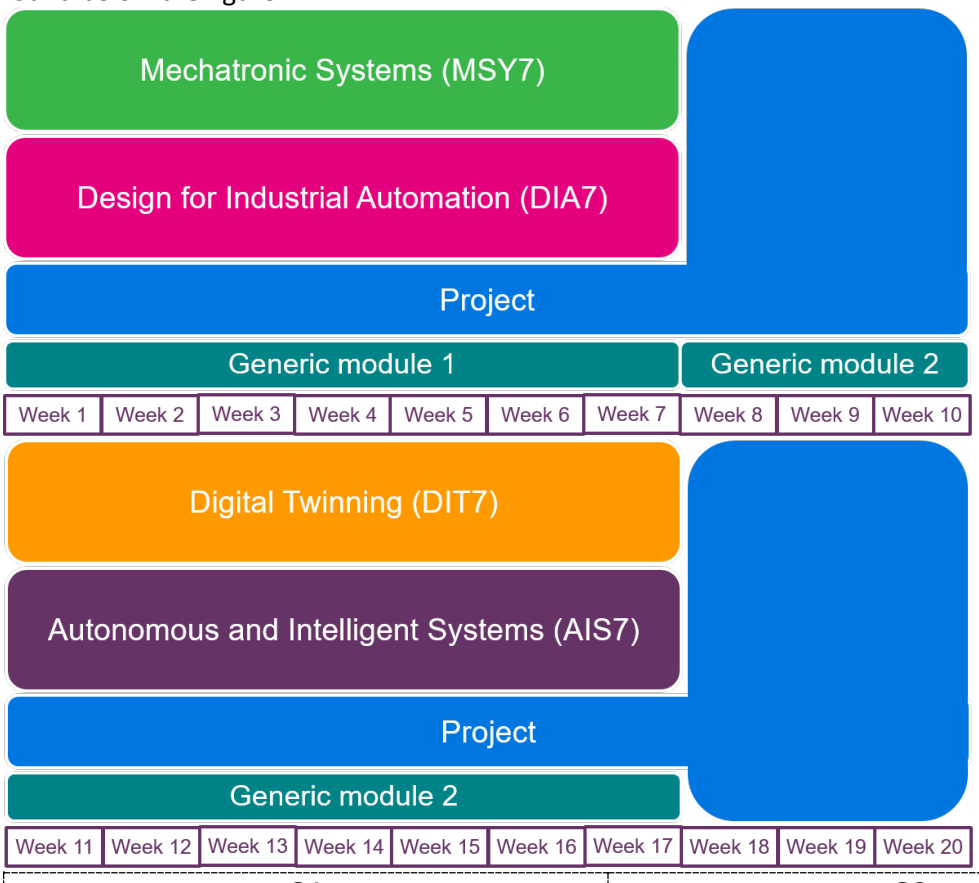


Q1	Q2
Applied Control Engineering – ACE 7	**Advanced Embedded Systems – AES7**
The course focusses on the complete control design process for mechatronics systems. Students will be able to design a controller (both in the continuous domain as well as the digital domain) based on a given model. Furthermore, the course focusses on techniques such as loop shaping, feed forward design, nested control loops and reference function design to improve the controller performance based on frequency domain measurements and experiments on a practical setup.	In the mechatronics environment high advanced embedded systems are used for the high-tech industry and robotics. The course advanced embedded systems for developing an advanced digital system. In the course, the ZYNQ chip from Xilinx will be used. The ZYNQ chip consists of an ARM9 microcontroller with an FPGA. In the course students will learn how to setup an architecture with the ZYNQ chip.
Dynamic Modelling and Design – DMD7	**Observers – OBS 7**
In this course, you will learn to draft dynamic models of (servo) systems. This so called white box approach, will provide you high level system knowledge, enabling you to predict the dynamic behavior. This white box approach thus not only enables you to influence the outcome of the system, but provides you tools to optimize the servo system, taking mechanics, electronics and the control strategy into account. A true mechatronics approach.	Pre-requisite: ACE7 State space representations will be used to design controllers that perform better than frequency domain controllers. Besides, it will be taught how the number of sensors can be reduced by intelligently calculating what the system's states would be. These sensor replacing algorithms are called observers. That way one can use the sensors that are already available on the system and simplify the design.

Differentiation 2: Adaptive Automation Systems (AAS)

Differentiation 2 is mainly focused on the shift from production in dedicated production lines with a fixed layout and processing order for a product or product family, towards intelligent, more or less autonomous, processing stations that can be combined in an ad-hoc way depending on the desired product. In short: adaptive and flexible automation.

The general overview of the differentiation is given in the figure below, a short description for the modules can be found below the figure.



Q1	Q2
Mechatronic Systems – MSY7	**Digital Twinning – DTW7**
This module enables the student to construct a model-based integral system architecture of a mechatronics system. Moreover, the physical constraints of the (sub-) systems have to be taken into account. The student has to be able to divide the system into subsystems and set up a system architecture. Furthermore, the module will focus on analogies between, and multi-physics state-space modelling of, the various mechatronic disciplines (electrical, mechanical and control/software) to obtain a design that is properly balanced between these disciplines.	Our world is changing. Industries everywhere are increasingly global in footprint and digital in their operations. As the world rapidly evolves, so must the way you manufacture. Digitalization enables you to mirror your manufacturing value stream with a virtual one, to quickly and cost-effectively create and test new concepts and ideas (and ultimately create a more customer-centric, agile and sustainable business). Central in this course is to show a different approach for developing and manufacturing using an digital twin approach. You will understand and learn how this approach can be beneficial for you and the client.
Design for Industrial Automation – DIA7	**Autonomous and Intelligent Systems – AIS7**
This course focuses on the design of industrial automation processes to enable flexible automation. Based on conditions such as serial size and desired flexibility, the course aims at the design of a flexible production street and/or production cell. Production layout can be optimized taken into account aspects like, required volume, lead time, process time and other relevant production definitions. Furthermore designing tooling concepts (such as grippers) that can be used for multiple (variants of) product, as well as topics such as quality and durability are part of this course.	Algorithms are the foundation of many intelligent, autonomous and adaptive products. These algorithms often act as decision makers for a given task or situation. Simple algorithms are reactive, meaning that a given input is interpreted with some simple rules and results in a direct action. More advanced algorithms first compute any possible outcome, and then make a decision that is most optimal given the current knowledge and input value. Learning algorithms analyze historic input data and try to predict or influence an outcome based in this previous “knowledge”. In this course we will explore several Machine Learning and Deep learning implementations.

Description of the professional profiles

Profile 1: System Design and Upgrade

In the role of a system designer you have to analyze the problem and figure out the customer needs. You will design in a methodologic way and you generate and weigh different solutions. You are aware of the impact of the design on the society (health/safety/environment/sustainability/ethical). You knows how to realize your design according to pre-identified requirements, using your production and material knowledge and/or simulations.

In the role of a system upgrader, you are looking for a challenge in upgrading an existing product. For this, the existing product is tested, the results are evaluated and analyzed and a new design question is developed based on this evaluation and analyzation. You will also focus on the life cycle of the product.

Generic module 1	Generic module 2
System Engineering and Architecture – SEA7	**Machine Safety and Testing – MST7**
In the module System Engineering and Architecture design in a methodologic way is the key. You will learn some skills and tools for designing a complex system in a structured way. Think about defining and refining the problem definition, functional decomposition, making informed choices, taking into account the product life cycle, the realizability and the costs.	Machine Safety and Testing is a module aimed at an introduction to machine safety and the testing of (parts of) machines. Students learn, among other things, about the process flow of machine safety. In addition, to perform and detail a (concise) risk analysis and risk assessment. Furthermore, the Machinery Directive and standards that can be used for the safe design of (parts of) machines are discussed in combination with the design of a safety system. Separate attention is paid to proper testing of requirements for (parts of) machines or systems.

Profile 2: Applied Research

In the role of an applied researcher, you engage in applied research to answer social issues. You will develop in conducting research by using the right methods and techniques. This includes setting up and conducting experiments, data analysis, source research, including standards and safety norms.

All this, to provide answers to social issues. The student is therefore able to identify the question and formulate a design problem based on the research.

Generic module 1	Generic module 2
System Engineering and Architecture – SEA7	**Applied research – APR7**
In the module System Engineering and Architecture design in a methodologic way is the key. You will learn some skills and tools for designing a complex system in a structured way. Think about defining and refining the problem definition, functional decomposition, making informed choices, taking into account the product life cycle, the realizability and the costs.	In the module Applied Research you will be supported in the skills needed for applied research projects. You learn to generate the correct search terms to find useful literature. You learn to validate your sources. Using your sources you are able to create an experiment or simulation, which results in a well-founded answer to the technical research question.

Profile 3: Project Coordination

In the role of a project coordinator, you guide organizational processes and employees, aimed at realizing the goals of the project. In addition, you provides well-founded advice on the design, improvement or application of products, processes and/or methods.

You are curious to the new innovation in which an international orientation is necessary. In addition, you develop yourself with the help of self-reflection and self-assessment.

Generic module 1	Generic module 2
Project Management for Engineers – PME7A	**Project Management for Engineers – PME7B**
In the first part of Project Management for Engineers you will learn more about the management and advise skills, which are needed for an engineer. You learn how you can monitor the scope of a project. To monitor and redirect this scope, a socially safe work environment is needed. Also an adequately customer relationship is needed.	In the second part of Project Management for Engineers you will learn more about the professional skills, which are needed for an engineer. Think about anticipation on changing preconditions within the project. Ethical dilemmas is also a topic. And reflection on your own actions, thinking and results are important.