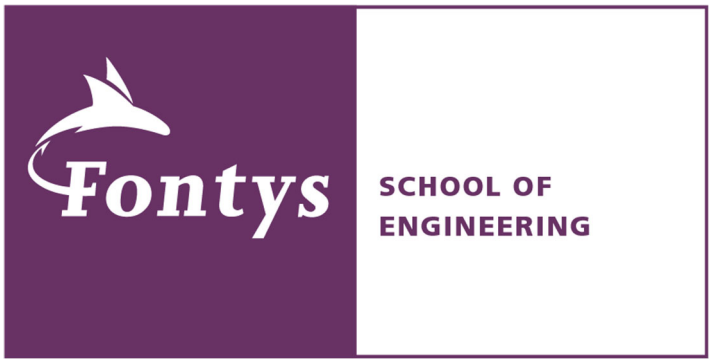
MODULE OVERVIEW OF MECHANICAL ENGINEERING ADVANCED EXCHANGE PROGRAM



MECHANICAL ENGINEERING ADVANCED EXCHANGE PROGRAM

CONTENTS

ADVANCED EXCHANGE PROGRAM PRECISION ENGINEERING

The Precision Engineering program will train you in the integral designing of precision machines. This includes mechanics, materials, production, dynamics, sensors and actuation and control.

There are 6 courses and 1 project in this program. The project is carried out with at least one company in the Brainport region involved.

PROGRAM CONTENT

Course code	Name	EC
WAPRS7	Project S7	10
MDSYE7	System Engineering 7	2
WADFX	Design for Excellence	2
WACM5	Design Principles for Precision	4
WAPM13	Production and Materials for Precision	4
WADG2	Dynamic Behaviour of High-Tech Systems	4
WACM10	Finite Element Method	4
TOTAL		30

COURSE DESCRIPTIONS

RESEARCH PROJECT (WAPRS7, 10 EC)

- Mandatory for: Precision Engineering, Energy Technology, Innovation Engineering

MODULES OBJECTIVES

To work effectively and efficient within a team actively applying management and group dynamic methods when needed.

- Planning and organizing your own work and the work of others - phasing and managing the project with respect to quality, logistics, time and costs (QLTC).
- Use and if required modify methods and techniques during all phases of the design process (entire V-cycle process).
- To be able to apply theoretical knowledge in the project in order to come to a design solution according to the set requirements.
- To be able to define the project/research assignment.
- To be able to independently investigate literature sources and acquire new knowledge where required.
- Making a complete design solution including all required documentation.
- Design a prototype with the required functionality, manufacturability and processes at acceptable costs.
- Validate the design regarding the within the project required functionality.
- To be able to translate client requirements into univocal and SMART defined system requirements and able to communicate effectively with stakeholders.
- To be able to reflect actively on the own performance and the performance of team members.
- Assessing the consequences of technical and / or commercial choices on functionality but also manufacturability, reliability, safety and costs.
- To provide oral and written explanations in both English and Dutch language.
- Make a written compact report (technical paper) in the Dutch or English language.
- To make a technical poster in the English language and provide argumentation during a poster session.

CONTENT OF THE MODULE

Under supervision of a project tutor students will work on an industry or society relevant project. Within this project students will need to design an integral solution including the validation of the proposed design.

During the semester students will meet and interact on a weekly / daily basis with the team, tutor and client.

PREREQUISITE KNOWLEDGE AND SKILLS

Experience in team cooperation, project management skills, report writing and presentation skills.

SYSTEMS ENGINEERING (MDSYE7, 2 EC)

MODULE OBJECTIVES

The main goals of the topics are to get introduced into the mechanisms of different environmental influences on the market success of a product or system, in order to apply to the engineering design process:

- Design & styling
- Marketing
- Safety: CE qualification
- Durability & Environment
- Quality in design
- The relevance of aspects to the design and design process
- How each aspect can contribute to a successful design
- What are the most important characteristics of each topic
- What are the consequences of the aspects to the design and design process
- How the aspects of each topic can be applied.

CONTENT OF THE MODULE

After several years obtaining insights and methods on technical design processes, you know how to design a well-functioning product or system. Requirements however mainly refer to the functionality of that product. But a well-designed product does not automatically guarantee that it will be successful in the market. The success is dependent on other influences of the environment, like a growing attention to sustainability, the market, presence of a financial crisis, styling, price, service and quality perception of the consumers. These influences may (strongly) change in time and may make or break the success of a well-functioning product. These influences are difficult to change. A product or system designer however can take the probability of these environmental influences into account. Thus, it is important while focusing on the design criteria to incorporate those taking external influences into account with a wide and strategic view.

This module provides a further introduction into several relevant themes:

- Design & styling
- Marketing
- Safety: CE qualification

PREREQUISITE KNOWLEDGE AND SKILLS

Background knowledge in system engineering is required such as the system engineering V-cycle, methodological design method(s) and requirements management.

DESIGN FOR EXCELLENCE (WADFX, 2 EC)

MODULE OBJECTIVES

Handle multi-disciplinary aspects in development projects

- Underpinned decision making with regard to value and importance of product specifications
- Achieving consensus on final product specification / project results with a team where members have different goals
- Using ”Design for” methodology and tools to facilitate

CONTENT OF THE MODULE

Introducing value of multi-disciplinary approach compared to mono-disciplinary approach.

- Assignment to get familiar with the various “Design for” methodologies and research on DfX approaches.
- Apply the multi-disciplinary approach and best matching DfX approach on the running project.
- Choose the best tool to come to an underpinned decision w.r.t. direction of the project.
- Presentation how the results of the DfX assignment have been achieved.
- Presentation of values and their importance of most important aspects (minimum 5, maximum 8) including underpinning.

PREREQUISITE KNOWLEDGE AND SKILLS

No specific background knowledge is required.

DESIGN PRINCIPLES FOR PRECISION (WACM5, 4 EC)

MODULE OBJECTIVES

- Being able to communicate with professionals.
- Design for accuracy (system on target as good as possible).
- Design for precision (system does the same every time).
- Keeping in place an object or machine part.

CONTENT OF THE MODULE

In this mechanical oriented module you will learn which physical phenomena influence the precision, reproducibility and accuracy of a mechanical system. Useful models are introduced to predict and analyse system behaviour. Design concepts are offered to conceive a system that has the potential for optimal behaviour. You will learn how to perform calculations of essential elements of a system to predict the behaviour.

What will you learn?

- Understanding the meaning of accuracy and precision
- Knowing the phenomena that influence accuracy and precision
- Make useful models of systems
- Calculate essential elements to predict accuracy and precision
- Choose suitable design concepts

PREREQUISITE KNOWLEDGE AND SKILLS

For this module a sound background knowledge concerning statics and mechanics of materials is required such as:

- statically determined and over determined structures
- moments of inertia, center of gravity
- bending of beams and elements (stiffness)
- bending, shear and torque stresses including combined stresses
- to calculate with multi-element construction including working with spring stiffness’s of the construction elements
- buckling
- representing constructions using parallel and serial spring elements

PRODUCTION AND MATERIALS FOR PRECISION (WAPM13, 4 EC)

MODULE OBJECTIVES

Explain the importance and industrial relevance of precision manufacturing and to know which materials are commonly used in precision applications.

- Understand and apply advanced machining and additive methods.
- Understand and apply surface treatments and coatings for performance enhancements.
- Analyse and apply the performance of ceramics, composites and lightweight metals.
- Analyse and evaluate precision measurements.
- Evaluate and apply wear resistance under different conditions.
- Work with contamination control and vacuum conditions.

CONTENT OF THE MODULE

Modern High Tech designs require ever increasing needs for precision manufacturing technologies not only into the range of µm's but even progressing into the range of nm (nanometres). With conventional processes the limits in precision are found in the micro meter regime by subtractive processes. For higher accuracies Electrical Discharge Machining (EDM) or Electro Chemical Milling (ECM) or working with high energy beams, such as lasers, ion beams or ultrasonic are opening up new possibilities. In particular micro-additive manufacturing is applied e.g. with lasers or electroforming.

This module concentrates on the basic principles of Production and Materials for Precision with some well-chosen examples that illustrate the progress and impact and show how to use these technologies as part of the (precision) design.

In an introduction the evolution of precision manufacturing will be indicated as a function of time in the area of both processing equipment and inspection equipment.

Topics of the module are:

- Micromachining using milling, turning and grinding
- EDM, ECM, laser micro machining and water jet cutting
- Micro additive manufacturing, surface treatments and coatings for performance enhancement
- Ceramics, composites and lightweight metals (Mg, Al, Ti alloys) for precision
- Precision measurement and characterisation methods
- Vacuum conditions, contamination control and wear resistance

PREREQUISITE KNOWLEDGE AND SKILLS

In order to follow this module knowledge regarding materials (metals and plastics), material properties and production fundamentals is required.

DYNAMIC BEHAVIOUR OF HIGH TECH SYSTEMS (WADG2, 4 EC)

MODULE OBJECTIVES

- Make a validated design of a dynamic precision system.
- Derive the differential equations (DE's) to describe a physical problem.
- Reflect critically on his/her own work and the work of class mates.
- Convert the DE's into a system of first order DE (state space description, SS).
- Convert the mathematical model into a Simulink model, including Simscape.
- Use both Simulink as Matlab to solve the model.
- Interpret the results of the model, analyse the effects of the parameters.
- Design a PID controller to meet the requirements using both the frequency domain and the IMC scheme.
- Design a SVF controller to meet the requirements using pole placement techniques.
- Implement the designed controllers to the physical setup.
- Interpret the results of the implemented controllers.

CONTENT OF THE MODULE

This module is aimed at understanding, designing and controlling of dynamic precision systems. Besides gaining theoretical knowledge part of the module consists of designing of a dynamic and controlled system.

The module consists of two main parts:

- Dynamic behaviour
- Control theory

During the part Dynamic behaviour the student will work on the design of dynamic system. This will for instance be aimed at a hard drive, production- or positioning machine. Design aspects such as bearings, actuator types, material choices and their impact on dynamic and control behaviour will be considered. Design choices will investigated validated using differential equations, Matlab Simulink and Matlab Simscape.

The part control theory is about using techniques to design and implement a controller of a dynamic system.

PREREQUISITE KNOWLEDGE AND SKILLS

For this module knowledge is required regarding differential equations, feedback control systems and setting up of transfer functions of control systems, Laplace transformations, basic design and tuning of PI and PID controllers. Also skills in using Matlab Simulink and programming in Matlab are required.

FINITE ELEMENT METHOD (WACM10, 4 EC)

MAIN OBJECTIVES

- Being able to use different types of meshes
- Being able to use different types of mesh connections
- Knowing how to find and solve errors in the simulation
- Being able to create a test program to validate a solver/solution process
- Knowing how to use post-processing correctly

CONTENT OF THE MODULE

During the design of complex precision systems, the use of Finite Element Methods is in wide use throughout the high-tech industry. One of the leading high end software suits for this is Siemens NX. In this course, the use of Finite Element Methods analysis using Siemens NX software will be investigated. An assignment at this level is used as an introduction. After that 1D, 2D and 3D elements are introduced and the connecting technique to combine these types of elements. These (combined) elements are used in five different types of solvers or solutions: structural, buckling, eigenfrequencies, fatigue and simple non-linear structural. Three of these are applied in the course and one of the other two must be done by the student himself in the final project. The intention of the module is that all exercises are validated with manual calculations.

PREREQUISITE KNOWLEDGE AND SKILLS

Prior knowledge of and experience with using an advanced CAD program such as Siemens NX, Solidworks of ProMechanica is required. Not only modelling skills but also initial knowledge of and experience with performing static lineair FEM analysis is required. Experience with Siemens NX is advised. Otherwise, students need to take into account that learning this software tool is the responsibility of the student in parallel to this course.