Minor keuzegids 2018

C.T.S.G. Alembic

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Miniminormarkt

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Preface

After choosing between process technology and material science for your eighth module you now face the next big choice in your educational career, choosing which minor you want to do. We made this booklet to guide you through the available choices and show you the experiences of older students through articles and presentations. We hope this booklet will be of use to you, and we hope that our successors build on our work and expand the guide for the years to come.

This booklet contains an introduction to the concept of a minor and a short explanation on the different kinds of minors available, followed by a short summary of all minors available to ST students, including experiences from other students when available. If a minor only has a Dutch description, it because this minor is only given in Dutch, this may change in the future as more and more programmes are switching to English.

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Contents

What is a minor?

In the third year of the bachelor programme, the first semester has no fixed subjects or exams, to obtain the 30 European Credits (EC) that you need for your degree, you have to construct your own curriculum. The university helps you with this by providing premade programs you can follow, called minors.

The most common kind of minor is the 'regular minor', the majority of these minors are part of an educational program. This means that you join a module of another bachelor, broadening your knowledge. Next to these broadening minors the university has developed special minors to deepen your knowledge. These minors are usually limited in accessibility, requiring you to have some previous knowledge to join the minor. The different minors can be differentiated by the phase of the module (M1, M2, M5 and M6 are broadening minors and M9 and M10 are deepening minor modules). Applying for these minors is possible from the 29th of march until the 16th of May 2018.

The second kind of minor the university offers is the High Tech Human Touch, or HTHT minor. These minors are developed to highlight the societal issues for which the UT is developing solutions through state of the art research. Most HTHT minors consist of two modules of 15 EC, but in nearly all cases it is possible to follow only one of these modules, as long as you cover the remaining 15 EC with an independent minor. These minors share the application deadline with the regular minors, so applying is possible until the 16th of May.

Next to these standard minor packages the university also offers options for people who want to switch to another field of expertise after their minor. A great example is the 'leren lesgeven' minor, after which you can start to teach classes at high schools. Other transitions are also possible, but are not always offered as a package, you have to contact the study advisor of the master programme you want to follow to decide on which subjects you will have to follow.

Last but certainly not least, you can decide to do a minor abroad! If you want to do this you will have to start your preparations early, as the application deadline is earlier that that of the standard minors.

Broadening Minors

Introduction to Civil Engineering – Civil Engineering – Module 1

Learning goals

On completion of this module, students should be able to

- Recognise the complexity of the civil engineering field and describe the relationships between different civil engineering disciplines
- Describe the basics of practical engineering (site investigation, project design, the basics of structural, water and infrastructure engineering)
- Explain how to use different design methods and apply the concept of limit states and actions (structural safety, serviceability and durability)
- Calculate loading, reaction forces and moments
- Determine the internal forces and deformation of beams and trusses
- Compare the physical and mechanical properties of the most common construction materials used in civil engineering
- Determine a basic concrete mix design in the laboratory using current methods
- Analyse laboratory test results for concrete samples (cubes and beams)
- Explain design requirements related to construction materials
- Apply Mathematical principles and Matlab coding in simple engineering applications
- Apply the basic project management and teamwork skills of phasing, work break down and meetings

Content

Module 1 consists of Mathematics, Matlab, Professional Skills Development and three civil engineering courses: Structural Mechanics 1, Construction Materials and Fundamentals of Civil Engineering. The aim is to introduce students to the basics of the civil engineering field and to develop an overall understanding of what it means to design a civil engineering structure. Within the module students will learn how to design a structural system, determine loading and internal forces, classify and compare the behaviour of the most commonly used construction materials (concrete, asphalt and steel), and get acquainted with different construction techniques related to the project. Each of the civil engineering courses, including Matlab, will be applied in the project, reinforcing the content knowledge of the course and developing students' understanding of a typical civil engineering project.

The project assignment for the 2017/2018 academic year is the redesign of a portion of an existing road and a bridge in the vicinity of the University of Twente. It includes the analysis of the requirements, the development of concept plans and the redesign of road and certain bridge elements. For some of the structural elements students will have to design the properties of construction materials, based on five practicums in the laboratory (soil classification, testing of aggregates, the preparation and testing of concrete cubes and reinforced concrete beam). The final project report will be a summary of all reports and students will have to present their final project at a presentation market and in front of an examination committee. Within the courses the work will be done and assessed individually and within groups. During the project, students will work in groups of ±6 students. All interim deliverables and the end result will be assessed as a group effort (with some elements of individual assessment) to ensure that the learning outcomes have been achieved by all students in the group.

Subjects & Exams

- Math A+B1
- Matlab
- Construction materials
- Structural mechanics
- Fundamentals of civil engineering
- Civil Engineering Design Project

Water Management – Civil Engineering – Module 2

Learning goals

- Learn about the management of natural water systems and the terms that are commonly used in this field.
- Learn about the hydrological, flow, transport and water quality processes in water systems and be able to describe these processes by simple mathematical models.
- Learn about the policy and social aspects related to water management problems, the possible conflicting interests an how to deal with them.
- Be able to develop simple analytical and numerical simulation models for various topics in water management and use these models to support decisions quantitatively.
- Be able to perform an exploratory problem analysis of a water management problem from different angles (technical, societal) making use of the provided knowledge and methods.
- Be able to carry out a project as a member of a team and give a presentation of the outcome of the project.

Content

The module Water Management focuses on the physical and policy aspects of water management. In this module students get insight in the behavior of different natural water systems and the effects of human interventions on these systems. Students get acquainted with the basic principles of policy processes such that they get insight in how certain objectives related to the management of these (natural) water systems can be realized administratively. An important aspect within the module is that the students learn i) to quantitatively describe and simulate the behavior of a water system with mathematical equations and models and ii) quantify the changes in natural systems by human interventions. Therefore, the module consist of the following parts

- Mathematics – Calculus
- Water (principles of natural water systems: water balances, hydrology, flow in open channels, etc.)
- Fluid Mechanics 1, including a practicum (experiments with water, measuring accuracies)
- Policy Processes
- Project

Project (2017-2018) The project focuses on the design of a dam and management of a reservoir in the Blue Nile in Ethiopia for the purpose of an optimal water distribution among different users. For different scenarios (e.g., meteorological conditions, user criteria) students (in project groups) have to propose a location and design of a dam. In a first exploring phase a Plan of Action needs to be written. After that a problem analysis is carried out aimed at the water management issues in the catchment of the Blue Nile. This is done from different perspectives (technical, societal, administrative), using information about this specific case, computer models (Matlab) for simulation of the water system dynamics, technical knowledge about fluid mechanics and methods from policy analysis. Next, based on this inventory, students choose an appropriate dam location and design and develop a simulation model (in Matlab) to optimize the management of the reservoir behind the dam based on the derived criteria and for different scenarios. In this project attention is paid to some specific skills, i.e. modelling in Matlab and the professional skills project management, information search and oral presentations.

Subjects & Exams

- Math B2
- Fluid Mechanics 1
- Water
- Policy Processes
- Project Water Management

Dynamic Systems – Werktuigbouwkunde – Module 5

Learning goals

Na afloop van de module kan de student:

- Een dynamische analyse uitvoeren aan een mechanisch systeem (kinematica, vrijlichaamsdiagrammen, bewegingsvergelijkingen, arbeid en energie, impuls- en impulsmoment, rotaties)
- Dynamische modellen opstellen in verschillende vormen (differentiaalvergelijkingen, toestandsvergelijkingen, overdrachtsfuncties, blokschema's)

Het dynamisch gedrag en een mechanisch systeem analyseren in zowel het tijddomein als frequentiedomein (stap- en impulsresponsie, Bode plot)
Een analyse uitvoeren aan een elektisch en elektro-mechanisch systeem (constituerende vergelijkingen, wetten van Kirchhoff)
De basisprincipes van precisiemechanismen toepassen bij het ontwerp van een nieuw mechanisme.

Content

Deze module combineert de werktuigbouwkundige disciplines van technische mechanica en werktuigbouwkundige automatisering. De module bevat alle noodzakelijke basiskennis die van belang is voor een succesvolle behandeling van de vakgebieden van de structurele dynamica en systeem- en regeltechniek.

Assumed previous knowledge
(additional) requirement(s) for minorstudents: UT Mathematics A, B1, B2, C1, D1 and Statics.

Beware! This module contains Mathematics D2, if this was already part of your program, you need to take a replacement course. Contact your program coordinator for more information.

Subjects & Exams

- Mathematics D2
  1 written test
- Dynamics 1
  2 written exams
- System Analysis
  2 written exams
- Project Precision Mechanics & Ac. Skills 5
  Exam + Project Essay + Individual Exam

Structures and Models – Applied Mathematics – Module 1

Learning goals

Upon completing the module, the student is able to:

- understand the principles of logic, set theory and proof techniques;
- give consistent and complete solutions tor exercises;
- formulate a first and second order differential equation, and find a solution for a differential equation using complex numbers;
- reproduce definitions and theorems of Linear Algebra and use them for solving exercises;
- prove properties of vector spaces and linear transformations;
- carry out a programming assignment in Matlab;
- develop and interpret a mathematical model;
- write a report about a mathematical model in LaTeX;
- improve intercultural communication with students of different backgrounds and is aware of the impact of their own cultural background;
- take responsibility about their own learning process.

Content

The subject Math β1 Bernoulli is part of the mathematics track at the University of Twente. In **Math ß1** a student learns to deal with abstract mathematics and to formulate problems mathematically using set theory, logic and proof techniques. Then first and second order differential equations and their applications are discussed and complex numbers will be introduced.
Linear Structures I focuses on developing the theory and understanding the structure behind solving systems of linear equations, difference equations and differential equations. The concepts that are discussed are vector spaces and related concepts such as linear subspaces; basis vectors; dimension; linear transformations; matrix representation; null space; image space; inverse; and determinant. The subject Linear Structures I lends itself well for the first year students to experience the abstraction of mathematics. It is expected that the students learn to establish a correct mathematical proof for the properties of vector spaces and linear maps.
One of the distinctive aspects of the Applied Mathematics is designing mathematical models. In the **Project**students will gain a basis for this skill. The project consists of an assignment in which knowledge of the other components of the module return, as well as necessitating learning to write a computer program in Matlab. The assignments are carried out in groups of four students. Each group produces a report written in LaTeX. On the basis of extensive feedback students learn the requirements for a good mathematical report. Because the program has an international character, the first module has a number of workshops that make students aware of the impact of cultural differences and helps them to deal with this.

Subjects & Exams

- Mathematics ß1
  1 written exam
- Linear Structures 1
  1 written exam
- Programming and modelling
  Assignment, project work and a report

Introduction to BIT – Business & IT – Module 1

Learning goals

This module aims to give students an overview of the field of Business & IT (BIT), by analyzing several business and IT problems from different perspectives, and teaching students how to design an integral solution. Students are supplied with the necessary know-how, and experience that design, research and decision-making can be done in a systematic way, as opposed to a merely common-sense approach. Secondly this module gives an overview of the topics to come during their bachelor program. Each week a new theme is introduced, which will be explained in one of the later modules in their studies. Finally this module aims to be selective. By giving students a good overview on the themes and the academic level of the courses, at the end of the module students should be able to understand if this is the right study program for them.

Content

During each odd week (1, 3, 5, and 7) teaching is focusing on a certain BIT theme. During the even weeks the BIT students will focus on the programming part of the module. The week themes (in the order of the first 8 module weeks) are: production management, programming and algorithms, information management, functional programming, supply chain management & sourcing, computer networks and operating systems, financial management, and Java programing.
Throughout the module most of the themes and the project follow the design cycle: Introduction –Analysis – Design –Implementation –Evaluation. The design cycle is core to all BIT modules. By connecting the teaching to the design cycle, knowledge and skills to be taught are put in context. Although project work starts right from week 1 of the module, from week 8 on the major focus is on finalizing the project. For the BIT students the project aims at designing and implementing an App for different users and or stakeholders of the Batavieren Race (Runners, spectators, Organizing committee, different assisting groups (doctors, first aid, parking planners, etc.).

Subjects & Exams

- Mathematics A + B1
  2 written tests
- Core Topics
  4 assignments
- Research Methodologies
  1 written test (multiple choice)
- Informatics Pearls
  3 written tests, 4 assignments
- Project Report & Product
  Report and end product

Pearls of Computer Science – Technical Computer Science – Module 1

Learning goals

Pearl 000 *Black pearl — Computer Architecture*
After absorbing the pearl "Computer Architecture"
• The student can work with binary and hexadecimal number representations, binary logic and boolean algebra.
• The student knows the basic architecture of a computer and its concepts register, memory, address, ALU, clock, program, program counter, instruction and mnemonic.
• The student can write simple programs for a microcomputer in machine language using arithmetic, I/O, and (conditional) jump instructions.

Pearl 001*Blue pearl — Algorithmics*
After absorbing the pearl " Algorithmics"
• The student can explain the importance of searching and sorting algorithms;
• The student can explain the principle of and differences between linear and binary search methods, as well as between bubble sort and merge sort;
• The student understands the complexity arguments behind the aforementioned algorithms and can analyse which is the best solution in what context;
• The student can apply simple imperative programming concepts: if/then, while, integer variables and arrays;
• The student can program the above algorithms in Python.

Pearl 010 *Green pearl — Databases*
After absorbing the pearl "Databases"
• The student knows the basic concepts of databases
• The student can design a database schema for a simple case using ER-modeling.
• The student can realize such a design in a relational DBMS using SQL.
• The student can query and update a relational DBMS with SQL.

Pearl 011 *Cyan pearl — Functional Programming*
After absorbing the pearl "Functional Programming"
• The student knows the basic concepts of the chosen functional language,
• The student is able to explain the concept of function application,
• The student understands the principles of recursion and their relationship with induction,
• The student is able to express simple algorithms in the chosen functional language.

Pearl 100 *Red pearl — Intelligent Interaction*
After absorbing the pearl "Intelligent Interaction"
• The student knows the basic concepts of artificial intelligence and can design a simple rule-based socially intelligent system.
• The student knows the basic principles of machine learning and can design and execute a classification task with a (black-box) classifier.

Pearl 101 *Magenta pearl — Computer Networks and Operating Systems*
After absorbing the pearl "Computer Networks and Operating Systems"
• The student can identify and explain the most important responsibilities of an operating system.
• The student understands the working and layered construction of packet-switched computer networks, and can reason about the therein occurring delays.
• The student knows the basic working of the internet and internet applications as well as the protocols like TCP, IP, and HTTP.

Pearl 110 *Yellow pearl — Cryptography*
After absorbing the pearl "Cryptography"
• The student understands symmetric-key encryption: block ciphers and their modes of operation, stream ciphers, and the one-time-pad. They know some basic design techniques of such ciphers, such as linear feedback shift registers and Feistel networks. Also, they know about the existence of DES and AES.
• The student understands asymmetric-key encryption: the RSA cryptosystem and the RSA signature scheme. They know how to use it for key exchange (hybrid encryption).
• The student has some necessary background knowledge of elementary number theory (modular arithmetic, Euclidean algorithm) and basic probability theory, for a proper understanding of the above mentioned cryptosystems.

Pearl 111 *White pearl — Requirements Engineering*
After absorbing the pearl "Requirements Engineering"
• The student can explain the importance of controlled and predictable realisation of software and project artifacts
• The student knows a few techniques for project management
• The student can derive and formulate requirements as well as acceptance criteria for them
• Besides reaching these learning goals, it is an explicit additional goal of this pearl to formulate requirements and set up a structure for the execution of the project of this module. Project After carrying out the project
• The student can coherently apply and integrate knowledge and skills in a team and for a project that is based on real-world aspects.
• The student has experienced going through all phases of realizing a software artefact

Academic Skills
After absorbing and carrying out the exercises of Academic Skills
• The student can explain the importance of working together in a team
• The student can effectively give an receive feedback
• The student understands and can apply the core quality quadrant model of Daniel Ofman
• The student understands and can apply the Belbin team role model
• The student can effectively resolve team conflicts
• The student can evaluate a project
• The student understands the concepts of fraud and plagiarism, and knows how to behave responsibly as a professional concerning these aspects

Contents

In this module, the student receives an introduction to eight 'pearls' of computer science covering the breadth of the discipline. One gets acquainted with computer architecture, programming of algorithms, encryption, software development, the internet as computer network, functional programming, artificial intelligence, and databases. Besides this, students work together on a project that either realizes a system that automatically and in an intelligent manner analyses and visualizes Twitter messages, or realizes a security system based on secure passes.

Subjects & Exams

- Pearls of Computer Science
- Project Pearls of Computer Science
- Mathematics A + B1

Software Systems – Techical Computer Science – Module 2

Learning goals

Concerning Software Design, after successfully finishing this module a student is capable of:

- Specifying an existing software system or a software system under design in terms of UML models (including class diagrams, activity diagrams and state machines).
- Interpreting these models, explaining the relation between different models, and between each model and the software code, and the usefulness of defining models in addition to writing software code.
- Explaining the commonly recognised phases of software development
- Applying version management in software development projects
- Explaining basic software metrics and using them to assess quality characteristics of a code base

Concerning Programming, after successfully finishing this module a student is capable of:

- Explaining and applying the core concepts of imperative programming, such as variables, data types, structured programming statements, recursion, lists, arrays, methods, parameters, and exceptions.
- Explaining and applying the core concepts of object-orientation, such as object, class, value, type, object reference, interface, specialisation / inheritance, and composition.
- Using the Model/View/Controller pattern when developing applications.
- Writing simple multi-threaded programs, and explaining the operation and problems (race-conditions) of concurrent threads, and using synchronisation mechanisms, such as monitors, locks and wait sets.
- Writing programs using basic network mechanisms, based on sockets.
- Explaining and applying the basic concepts of security engineering and applying them to Java programs.
- Writing software of average size (around ten classes) in Java,by using the concepts mentioned above, including the use ofalgorithms for searching and sorting data
- Documenting software of this size, by using (informal)preconditions, postconditions and (class) invariants, and (informally) justifying the correctness of the implemented software.
- Explaining how this software can be tested, defining and executing a test plan, and measuring and improving test coverage.

Concerning Academic Skills, after successfully finishing this module a student is capable of:

- Describing the major principles of effective time management.
- Applying these principles to make a personal planning for a medium long term period, e.g., a study semester, and for a medium-sized project.
- Formulating personal strengths and weaknesses with regard to time management, study behaviour and project work.
- Describing the major principles for defining a general project planning.
- Applying these principles when reflecting on some previous project planning.
- Giving and receiving peer feedback.
- Identifying major personal pitfalls concerning procrastination behaviour.

Concerning Mathematics, after successfully finishing this module a student is capable of:

- work with elementary properties of integrals and
  calculate integrals using different techniques, for functions of 1 variable
- work with power series and Taylor series, for functions of 1 variable
- solve linear differential equations
- work with complex numbers

Content

In this module the students are introduced to the design, implementation and testing of software systems, and to performing a project independently.

For the **design** of software systems, they learn to use Software Engineering models, particularly the UML diagrams (class diagrams, activity diagrams and statecharts), and they get acquainted with the waterfall software development processes.

For the **programming** of software systems, they learn the core concepts of program structuring, object-orientation and multi-threading with the help of the Java programming language, with attention to correctness by means of (informal) preconditions and postconditions. In addition, the module addresses security engineering aspects in the context of Java. In this module the students build upon the knowledge on algorithms and recursion acquired in Module 1. For testing software systems, the students learn to distinguish among the different levels at which testing can be performed (specially unit testing and system testing), the principles underlying a test plan and a couple of relatively simple testing techniques.

For **academic and project skills**, attention is given to project management, planning, time- and selfmanagement, and reflection on one's own behavior w.r.t. planning.

For the **mathematics**, this module contains the so-called 'Newton' package, which covers the theory of mathematical functions and integrals.

Subjects & Exams

- Design Theory
  Written exam
- Programming Theory
  Written exam
- Mathematics B2
  Written exam
- Design Project
  Report + modelling
- Programming project
  Report + code

Finance for Engineers – Technische Bedrijfskunde – Module 5

Learning goals

- Valuation
  Understanding of the main principles of financial valuation, and ability to apply the valuation techniques in determining the value of bond, shares, firms as well as simple financial options.
- Accounting / performance
  Interpret real world financial figures related to (external) financial accounting and (internal) management accounting.
- Decisions / management
  Understanding some basic principles underlying financial and investment decisions, and the ability to perform corresponding basic applications.
- Financial markets
  Elementary knowledge of financial markets and their role in corporate finance
- Methodology
  Knowledge and application of information elicitation techniques and multi-criteria analysis

Contents

In this module we give an introduction to the field of Finance. Concepts and tools are addressed, ranging from Accounting to Corporate Finance and a bit of Option Pricing. The level is tuned to second or third year bachelor students from a technical program, with some background in statistics and probability, including at least some familiarity with the concepts of variance, standard deviation, correlation, normal distribution, and statistical significance. Some financial pre-knowledge is desirable, for instance as treated in the financial week of the first module TBK/BIT.

We address questions like: what are costs, revenues, expenses, cash flows, and profits? How to keep track of the financial status of a company, and how to manage it? Can we express performance in financial terms? How to assess the value of an investment plan? How does risk affect value? Is the ultimate goal of a company to maximize shareholder's value? What should be in a company's annual report? How to finance my business? What do the financial markets offer companies in this respect? Do they exist to serve business, or is it the other way around? How are markets regulated? Why do financial options and derivatives exist?

There is a central role for a project in this module. The context will be provided by the annual reports of some companies that will serve as leading examples throughout the module. In the first weeks, emphasis is on connecting theory to the project context. In the second part of the module the project is leading – you will deepen your knowledge, and learn to apply concepts and tools in a case context. The project for this module is developed in cooperation with the Authority Financial Markets (AFM).

Subjects & Exams

- Accounting and Finance
  Schriftelijke toets
- Option pricing
  Schriftelijke toets
- Research methodology
  Schriftelijke toets
- Project

Personal Experience – Thomas Remmerts & Tijmen Vlogman – Finance for Engineers

Module 9 (first quartile)

Motivation

Both: The reason we chose this join-in minor/pre-master is that we wanted to learn more about financing. We were interested in the field of financing, which is not present in our current study program. In following this minor we wanted to find the link between Chemical Engineering and the financial part of chemical companies.

Pre-master: The pre-master is different than the original minor, as it has an extra course "Statistics and Probability Theory", while the minor has the course "Methodology". Next to this, the project is a little bit smaller for pre-master students. I was in doubt whether I wanted to follow the Chemical Engineering master or another master like Financial Engineering & Management. To find out which master I would be more interested in, I chose to do the pre-master.

Finance and accounting

Both: For the first 4-5 weeks there were 2 or 3 lectures and 2 tutorials per week. The lectures were kind of slow and low on information, which caused a pretty low attendance. There were several lecturers, but most of them were not very enthusiastic. The amount of information to be learned for the tests was pretty high, but the tests themselves were all multiple-choice and pretty easy compared to Chemical Engineering.

Option pricing

Both: This course had 1 lecture per week, for the first 4 weeks. This course went kind of hand-in-hand with the course *Finance and accounting* and were also tested the same and at the same time as the other course. This course had a bit more enthusiastic lecturer, but he was kind of difficult to understand because of his foreign accent. Also the subject was more calculation based, and focused on the share market, which I thought was rather interesting

Project (both minor and Pre-master)

Pre-master: The project I followed was kind of different from the normal minor project, because our group could skip the last 2 assignments. My group also consisted fully of other pre-master students, from several different studies. The project was very free in that you could choose your own topic entirely, but it had to be connected to the courses. We write a report on Donald Trump's influence on the market for example. The project was pretty fun and easy to do.

Join-in minor: In the project for the minor students I joined a group with only Chemical Engineers. With this same background, we decided that we wanted evaluate the financial part of a chemical company. In this we chose the (almost) acquisition of AkzoNobel by PPG, which was really interesting to investigate as it was a very actual topic and a lot of big change happened during the project itself.

Statistics and Probability Theory (5 EC, Pre-master TBK)

Pre-master: This course is specific for the Finance track of the Pre-Master of TBK. This was a very interesting course which I most enjoyed of the entire minor. There were weekly lectures, which were more tutorials than actual lectures. The lecturer said he would only present the first lecture and that following lectures would be question sessions mostly. This is different than with Chemical Engineering and it took some getting used to. However, I learned a lot from this course, which was also applicable to Chemical Engineering.

Methodology (5EC, Join-in module TBK)

Join-in minor: This subject is part of the ''skills'' track within TBK and focuses on data gathering and decision making. It was really different from the rest of the subjects as it was not very technical and more based on how to conduct research. The lecturers are a bit chaotic and hard to follow sometimes, but I managed to finish the subject relatively easy with some self-study.

Time intensity and comparison with Chemical Engineering

Both: The time that had to be invested into the minor/pre-master was significantly less than for Chemical Engineering. The minor was previously often referenced to as “free EC”, but that is of course not fully true. There were in fact almost only lectures that was planned, and a high level of independence was expected. This is also shown in the project, in that you can chose the topic yourself.

The amount of previous knowledge obtained in Chemical Engineering was by far enough to successfully do the minor/pre-master, except that some terms/jargon had to be learned. However, if you have followed subjects like economics or management and organization at secondary school, this will help your understanding of this part. A lot of different studies do the minor/pre-master, so the organization is very aware for the possible lack of knowledge caused by this.

The knowledge obtained during this minor/pre-master was not very relevant to Chemical Engineering, except for the probability and statistics. Especially statistics is very useful in Chemical Engineering, most noticeably in the master. The financial knowledge obtained can be useful in the field of Chemical Engineering as a sort of base knowledge, but is definitely interesting. It might also be useful if you want to follow the Cost Management course in the Chemical Engineering master.

Greetings,

Tijmen Vlogman

New Media – Creative Technology – Module 5

Learning goals

- Experience with creating larger scale New Media products.
- Basic theory, skills, and working knowledge of tools, for Sound Engineering.
- Basic knowledge and skills for Computer Animation.
- Skills for creating 3D graphics objects and animated characters.
- Insight in state of the art Virtual Reality and Augmented Reality techniques.
- Understanding of basic principles of Game Design.
- Being able to create and implement simple games using game engines like Unity3D.
- Have a working knowledge of mathematical principles for New Media.
- Understand how to explore literature, and how scientific research methods work.
- Practice with techniques for creating multimodal products and applications.

Contents

The “New Media” module aims at building various skills, learning theory, and understanding techniques, for New Media production. One of the goals is to actually produce New Media products like interactive media experiences or games, using techniques from sound engineering, various graphics techniques, and game theory. It is mostly a “tools and techniques” module where the focus is on creation of New Media while learning theory, experimenting with tools, techniques, and developing skills. The focus is on Sound Engineering, 2D/3D Graphics, Animation, Virtual Reality & Augmented Reality and Game technology. A major subject of the module is the creation of an interactive New Media experience, where many aspects you learn in the module come together. The courses on Sound Engineering, 3D Graphics, and Game Design also ask for smaller scale exercises and products. Next to these core subjects, students have their own Research Project, which aims at deepening knowledge on a New Media related topic of the student’s own choice This Research project also allows him or her to experience scientific exploration, and to build academic skills. Finally, we have a mathematics track, introducing mathematical knowledge underpinning concepts and techniques for New Media as well as for the mathematical track for the Create curriculum as a whole.

Subjects & Exams

- Sound Engineering
  Opdrachten
- Game Development & VR
  Product + presentaties
- New Media Project
  Product + eindpresentatie
- Mathematics for New Media
  Opdrachten
- Literature Research Project
  Eindverslag

Smart Technology – Creative Technology – Module 5

Learning goals

[Circuits &Electronics + Systems and Signals] Being able to characterise and analyse electric circuits regarding 1st and 2nd order systems in both time (step responses) and frequency (filters) domain with the aid of various signal descriptions, complex number theory, differential equations and LTI system descriptions; Implement, characterise and analyse electronic implementations of these systems, understand mathematical description of (electrical) signals

[Sensors] Being able to characterise and analyse in both theory and practice resistive, capacitive, magnetic, acoustic and optical sensors and their interface circuitry. Understand the effects of making a transisition from the physical domain to the digital domain.

[Control Systems + Systems and Signals] Being able to model and analyse dynamical systems using various methods and representations in both analog and digital implementations with the aid of Laplace transformation and block diagrams. Characterise, analyse and implement feedback control (PID) in digital and analog domain and understand the mathematical representations.

[literature research project] Being able to do a scientific literature review based on a personal fascination in the Smart Technology context in order to obtain the scientific insight needed to produce new ideas, services or products

[Professional Development] Reflect about the role of smart technology in the profession as a creative technologist

Contents

This module and its counterpart (Module 5b: New Media) are so called “Tool” modules. In order for the CreaTe student to exert his profession some fundamental knowledge of frequently used tools is necessary. The Smart Technology module focuses on providing such tools on an academic basis. The focus in this module is on physical (mostly electrical or mechanical) systems like electronics, sensors, controlled systems and the interfacing of such systems to the digital world. In addition, signal descriptions in time and frequency domain play an important role, as well as modification, modulation and conversion of signals in time and frequency domain. The treatment of some of the underlying (physical) principles governing such systems will go hand in hand with the treatment on the system level. Practical (lab) skills will play an important role to provide the link between theory and application. In addition, this module contains an individual literature research project which provides the student the opportunity to follow his fascination in technology and deepen his knowledge on smart technology, for example on a Human-Interface-Device related topic such as Haptics.

1. **Project and Professional Development**. The project enables the student to follow his fascination in Smart Technology and deepen his knowledge. This project will be a literature based project and not a “make and prototype” project. Via the professional development topic the student can reflect both on the things learned during the project and during the courses and become conscious of the means and ways to stay up-to-date and focused on the relevant knowledge and developments in the context of his or her Creative Technology study and later profession.

2. **The Smart Technology related topics**. These show strong ties and interconnections towards each other. They serve both the purpose of necessary theory and/or ideas for the project and providing the student with the relevant understanding and mastering of some of the most important concepts, operating principles and theory of present day electronic Smart Technology and Smart Environments.

- The foundation of Smart Technology is Circuits and Electronics in which passive and active electronic components and the analysis and operation of basic electric circuits (transients, filtering, amplification, etc.) will be laid down.
- Sensors is about connecting the physical world to the digital world. Sensors will be treated according to the physical domain in which they operate and will be characterized in practical lab session. The interfacing from analog to digital world also plays a crucial role.
- The Control Systems topic focuses on modelling (mathematical models, simulation models) of both controlled and uncontrolled systems. Furthermore, the basic principles of feedback control (e.g. PID) in both the analog and digital domain will be treated.

3. **Systems and Signals** provides the necessary math supporting the Smart Technology related courses. Topics treated include trigonometric functions, Fourier series and Laplace Transformation for describing signals in both the time- and frequency domain. The math is integrated with the other topics in order to keep a close relationship between mathematical foundation and the application within the ST context.

Subjects & Exams

- Circuits & Electronics and Signals
  4 exams and labjournals
- Sensors
  2 exams and assignments
- Analysis and Control of Systems
  Project literature research

Facilitating Technological Change – Communication Science – Module 5

Learning goals

This module includes four components:
2.1 Project: Stakeholders and Technological Innovations
2.1 Theory: Science Communication & Public Relations
2.1 Research Methodology: Qualitative Methodology 2
2.1 Academic and Professional Skills: Popularizing Science

2.1P: Stakeholders and Technological Innovations
At the end of the module, students will able to…:
analyse a technological innovation from a system perspective;
write a strategic communication plan based on literature, stakeholder analysis, and output from focus groups and media-analysis;
inform the general public about technological innovations by means of a popular background article and an infographic;
operate effectively in a smaller project team and in a larger editorial team;
contribute constructively to discussions and give mutual, constructive feedback while working in a team;
make and publish a popular science magazine.

2.1T: Science Communication & Public Relations
At the end of the module, students will be able to…:
explain relevant concepts related to the social dimensions of innovation and technological change:
a. the meaning of innovation in various contexts;
b. dimensions of innovations beyond its technological side;
c. systemic character of innovation and technological change;
d. governance of responsible research and innovation.
analyse relevant stakeholders involved in innovations and technological change;
explain the role of media in technological change;
explain theoretical concepts in science communication;
reflect on the role of communication when designing and implementing new technologies.

2.1R: Qualitative Methodology 2
At the end of the module, students will be able to…:
explain the principles, execution and procedures of qualitative research;
explain and evaluate the contribution of focus groups and media analysis as research methods;
conduct focus groups and analyse the output;
conduct media analysis and analyse the output;
deduce practical implications from the results of both focus groups and media-analysis.

2.1S: Popularizing Science
At the end of the module, students will be able to…:
inform the general public about technological innovations by means of a popular background article and an infographic;
write a popularized journalistic background article based on complex information;
make an easy-understanding infographic of complex concepts by following an iterative design process.

Contents

Technological innovation projects usually involve many different stakeholders that have a ‘make-or-break’ influence. The government, for example, influences the development of technological innovations through regulations and subsidies. Private investors play a pivotal role in financing new projects, and the general public in the legitimization of technological innovations. Whether new technologies succeed or fail depends to a large extent on effective communication with these stakeholders.

This module addresses the development of technological innovations from a system and stakeholders perspective. Students learn about the key processes of innovation and the different stakeholders involved in those processes. The knowledge acquired serves as input for a communication strategy to advance the development and implementation of a specific innovation.

The general public is a crucial stakeholder in innovation projects. Students learn about motives, perspectives and interests, and how to influence the public using the heuristics of science communication and public relations. Furthermore, students work on a popular scientific magazine, setting up their own editorial office, to educate the general public about various technological innovations that have been developed at this university.

2.1 P: Stakeholders and Technological Innovations
The project consists of two parts. First, working in their project teams, the students write a strategic report on the development and implementation of a technological innovation developed at the University of Twente. The strategic report is based on the system perspective and a stakeholder analysis and focuses on how (in terms of means and messages) important stakeholders should be addressed.
Second, students are required to address the general public by creating a popular scientific magazine about technological innovations used in the first part of the project. Based on a media analysis and focus groups, students write a popular article about their innovation within their groups. With four other groups they form an editorial office, consisting of text editors, journalists and visual editors, to publish a complete magazine.

2.1 T: Science Communication and Public Relations
In this module component, students acquire an understanding of strategic communication theories and the technological innovation system perspective. Both paradigms are required by communication professionals to facilitate technological change. Strategic communication theories in this context consist of stakeholder management, public relations and science communication. The technological innovation system perspective covers the key processes of innovation, including: knowledge development, resource mobilization, legitimization, entrepreneurial experimentation, market formation, the influence of the direction of search and the development of positive externalities.

2.1 R: Qualitative Methodology 2
To understand the needs of the general public and how these should be approached, students are introduced to two qualitative research methods. By means of media analysis, which includes making a codebook and analysing a large number of media articles by using the software Atlas.ti, students learn about the frames used by journalists to describe a technological innovation. Secondly, the students learn more about the perspectives, interests and motivations of the general public through focus groups. Students will make an interview scheme, guide participants through the focus group session, and code and analyse the answers by using the software Atlas.ti. Both methods provide input for the popular scientific magazine.

2.1 S: Popularizing Science

In this module component, students will learn how to write and visualize innovations in an accessible way. Students learn how to write popular articles by applying the principles of journalism. From a designer perspective, students learn how to explain a technology using an infographic.

Creating Biological Tissues – Biomedische technologie – module 5 - Dutch

Learning goals

In het project zullen de studenten een tweetal strategieën gaan ontwikkelen voor de behandeling van een (musculoskeletair) ziektebeeld met behulp van stamcellen. Een belangrijk deel van de informatie en materiaal dat benodigd is voor het uitvoeren van het project, zullen studenten zelf moeten verzamelen en verwerven. Hiertoe is wel ondersteuning onder andere in de vorm van de workshop Academisch Informatie Verwerven.
In de praktijkopdracht gaan de studenten op basis van literatuurgegevens een groot experiment vormgeven en uitvoeren waarin mesenchymale humane stamcellen gedifferentieerd gaan worden naar een celtype uit het bind-en steunweefselsysteem (bijv. vetcel, botcel, kraakbeencel). Tevens moeten studenten een keuze maken uit verschillende moleculair biologische en cytochemische analyse technieken om te bepalen of de differentiatie inderdaad geslaagd is. Over dit deel moeten studenten een onderzoeksverslag schrijven en een labjournaal bijhouden.

In de theoretische opdracht (Theoretical Design) komen de studenten met een voorstel om een ziektebeeld naar keuze te gaan behandelen met stamcellen die genetisch gemanipuleerd worden. In het verslag gaan de studenten met name in op de techniek die gebruikt wordt om de cellen genetisch te manipuleren alsmede hoe deze gemanipuleerde cellen teruggeplaatst kunnen worden in de patiënt. Het gebruik van stamcellen en genetische manipulatie is onderwerp van uitgebreide maatschappelijke discussies. Het project wordt dan ook in een ethisch- maatschappelijk kader geplaatst en wordt afgesloten met een debat. Tijdens een workshop worden studenten geleerd hoe een debat te voeren. Studenten maken tijdens een aantal hoorcolleges en werkcolleges kennis met ethiek en leren vanuit verschillende ethische theorieën te argumenteren. Om interactie en discussie te bevorderen zullen deze bijeenkomsten in kleine groepen worden gegeven. Tot slot schrijven de studenten een kort individueel procesverslag waarin zij reflecteren op hun bijdrage aan de verschillende onderdelen van het project en de ontwikkeling van hun ethische en morele overtuiging.

Een groot deel van de theorie en de moleculair biologische technieken voor het succesvol uitvoeren van het project wordt aangeboden in de practica, colstructies en werkcolleges behorend bij het vak Toegepaste Celbiologie. Inde hoor- en werkcolleges Ethiek wordt aandacht besteed aan het plaatsen van het gebruik van stamcellen en genetisch gemodificeerde cellen in een maatschappelijk kader. Tevens heeft het vak Structuuranalyse ook raakvlakken met het project en het vak Toegepaste Celbiologie. Dit vak geeft een overzicht van, en introductie tot, de moderne spectroscopische technieken die gebruikt worden in de kwantitatieve en kwalitatieve analyse van moleculen. In dit kwartiel wordt daarnaast het lijnonderwijs Wiskunde Math D2 Gauss gegeven. Dit vak maakt geen deel uit van het project.
Voor specifieke learning goals van het project en de ondersteunende vakken in deze module wordt verwezen naar de modulehandleiding op Blackboard.

Subjects & Exams

Project Creating Biological Tissues 6 EC weegt 42% mee in eindcijfer
Onder te verdelen in:
- Onderzoeksverslag van projectexperimenten incl. labjournaal voldoende + werkhouding op lab is voldoende is =40% Groepscijfer.
- Theoretical design Creating Biological Tissues using Genetic Manipulation (in sillico experiment) is 30%. Groepscijfer
- Debat Ethiek stamcellen &genetische manipulatie incl. diagnostische -toets en opdrachten voldoende is 25%. Groepscijfer met individuele component (uit toets en opdrachten).
- Individueel procesverslag is 5 %. Individueel cijfer.
- Voldaan aan aanwezigheidseis bij (gast)colleges ihkv project om eindcijfer voor project te verkrijgen..

De ondersteunende vak domeinen zijn alle Individuele cijfers
Onder te verdelen in:
- Toegepaste Celbiologie 5EC, 32%
- Structuuranalyse 2 EC, 13%
- Math D2 Gauss 2EC,13%

Microscopic Cancer Detection – Biomedical Engineering – Module 2 - Dutch

Content

The main research question of the project in this module is ‘’To what extent is it possible to correctly determine the origin of a cancer metastasis using a panel of selected biomarkers and a so-called compound microscope. The findings are validated using a commercial microscope. Students have to propose improvements to their microscope as part of the concluding poster session and labjournal.

The courses Geometrical optics and Cell Biology are the corner stones of the project, both in a theoretical and practical sense.
The course Cell Biology will address several topics such as the central dogma DNA-RNA-protein including the regulation of these processes, the cell cycle and the molecular basis of cancer. In two histological practicals students will learn about the relation between form and function and normal vs. cancerous tissue.

The Geometrical Optics course will cover the following topics:
- Nature of light (wave or particle)
- Description of domain of geometrical and physical optics
- Radiometric units
- Reflection and refraction (non-curved and curved surfaces)
- Lens equation
- Lenses, loupes and eyepieces
- Endoscopy
- Microscopy
- Design and implementation of simple optical experiments.

In module 2 Math B2 Newton will address a variety of mathematical topics. Also a case study will be incorporated which links to the project.

Subjects & Exams

- Project: Microscopic detection of Cancer
- Geometric Optic
- Cell Biology
- Math B2 Newton

Signals, Models & Systems – Applied Physics/Advanced Technology– Module 5

Learning goals

After this course the student is able to:

1. Create a description of physical (electrical, thermal, mechanic and physical transport) systems in terms of a set of (ordinary) differential equations, using principles like conservations laws and continuity relations.
2. Describe a distributed system as a set of linked lumped systems.
3. Solve analytically the response of a system described by a set of differential equations in terms of stability, eigenvalues and eigenmodes and is able to interpret the solutions.
4. Analyze system behavior through simulation tools and discuss the validity of the model representing the system. Interpretation of system properties via the response of probe signals (pulse, step and trend). Understands the concept of transferfunction.
5. Understand the relation between time and frequency domain and can describe and use the basic properties of Fourier series and Fourier Transformation and use Laplace transform to solve a differential equation.
6. Understands the difference between the continuous and discrete time and frequency domain and can perform a discrete Fourier Transform and use z-transform techniques to solve a differential equation.
7. Can choose a correct digital sampling frequency and can design a digital filter with the aid of z-transform techniques.
8. Can describe stochastic signals with zero order (moments: mean, variation, skewness, etc) and first order statistical methods (correlation techniques.)
9. Understands the principles and the influence on stability of feedback. Can implement a P, PI or PID controller in a system control design
10. Can understand and develop a small Labview program to control a measurement.
11. Can define a design/research project and function as project team member, name milestones in the project and defend the choices made to achieve the goals set by the milestiones.
12. Can report on results from a design/research project and reflect on the quality of this work.

Contents

This module provides an introduction in the principles of modeling and analyzing dynamic systems. A sufficiently realistic description of a (sub-) system is translated to a model that allows a mathematical description in the form a set of differential equations. The models are based on basic principles like conservation laws and continuity relations. These principles are introduced using a wide range of examples from physics and chemistry, i.e. from different disciplines like dynamics, electrical networks, fluid and heat transport. The ability to probe system dynamics via signal response is elucidated. The description of signals in both time and frequency domain (Fourier Transform) will be used to elucidate mathematical techniques for solving linear differential equations (Eigenvalues, Laplace Transform). The dynamic behaviour of systems is further analysed by simulations and the adequacy of the model description will be discussed. The description and analysis of stochastic signals will be treated. The theoretical description will be facilitated with a few experiments.

The system analysis part starts with an introduction to Labview. After this 4 experimental problems have to be solved. These are in the area of
1) system characterization,
2) feedback dynamics and control systems,
3) modelling of distributed systems and
4) digital filtering.
In the project students have to solve a problem formulated by themselves in the field of signals, models and systems using (part of) the techniques acquired in this course.

Public Management – European Public Administration – Module 5

Learning goals

At the end of the module, the students will;
demonstrate knowledge of public management theory and concepts needed to study the management and performance of a particular (semi)public organization,
demonstrate knowledge of qualitative research design and research methods,
Students are able to analyze the performance of a particular (semi-) public organization from theories of public administration and –management,
explore different career paths, reflect upon their preferences, and practice with preparing towards pursuing their goal.

Contents

The sub-field of public management covers the internal and external functioning of organizations in the public and semi-public sector—defined in a very broad sense—as well as the effects of this functioning on the performance of these organizations (e.g. innovativeness, effectiveness, and legitimacy). Performance is conceptualized primarily from the perspective of the creation of public values: values that are important to society as a whole—rather than making a profit on a consumer market. Public organizations;
a) contribute to, and help to accomplish, collective public values and interests;
b) at least partly depend upon public funds and other resources.
The (semi-) public sector is defined much broader than "government" in its traditional sense. It also encompasses the activities of non-profit organizations and even the interactions between public and non-profit sector organizations with private sector organizations when such public-private partnerships serve the public interest.

The theoretical core of public management research is based on a number of basic assumptions, which have been elaborated and supported by (evidence-based) theoretical-empirical research. The starting point is that the study of (semi-) public organizations requires a specific scientific approach, which is fundamentally different from the study of organizations in the private sector. Central is the observation that (semi-) public organizations operate in a political-institutional environment which is quite different from consumer markets. Consequently, we cannot simply import practices from the market sector into public sector reforms. Therefore, much of the current research in the field of public management has been devoted to debunk the premises of "New Public Management" and the privatization of government services.

The influence of the political-institutional environment of (semi-) public organizations has two important consequences for the study of public management. The first consequence is that public management, as a field of study, focuses on the interdependence between semi-public organizations and their environment. The environment of (semi-) public organizations consists of interdependent other organizations, institutions, and (organized) citizens. The second consequence of the influence of the political-institutional societal environment is that the field of public management has a broader focus than processes and activities within and between organizations. This broader focus includes effects of organizational internal and external functioning on performance, that is: quality of public service delivery in terms of its efficiency, effectiveness, equity, legitimacy, and client satisfaction.

The module on public management starts from these two foci (organizational environment and organizational performance). During the module, students study issues that relate to the effects of internal and external management of (semi-) public organizations. For a proper performance, public organizations must tap necessary resources from their interdependent environment, and must buffer from shocks in their environment. While “getting more done with less” (in terms of resources) is often used as a slogan for public sector reform, the fundamental issue is “how to manage the use of resources as effectively and efficiently as possible, given the necessary quality of public service delivery?”

Subjects & Exams

- Management of Public Organization
  Schriftelijke toets en assignments
- Research Methods and Techniques
  Schriftelijke toets
- Project: Organizations
  Assignments
- Career Orientation in their Context
  Written assignments

Technology, Organization & People – International Business Administration – M1

Learning goals

Upon completion of the TOP module, students can describe organizations in terms of their design, technology and people; work on a project to describe a real-life organization based on theories taught; and analyze the effectiveness of this organization. In addition, students will get a first impression of the other business administration disciplines, such as management accounting and corporate finance, technology and innovation management, strategic management, information systems, human resource management, and organizational behavior.

Upon completion of the TOP module, students are expected to (be able to):

- Recognize and distinguish between various perspectives on the evolution of organizations and on organizational effectiveness
- Memorize definitions of organizational environment, strategy, technology, culture, size and structure
- Recognize and distinguish between various types of organizational environment, strategy, technology, culture, size and structure
- Memorize theories about relationships between organizational environment, strategy, technology, size and structure

- Evaluate and select conceptualizations of organizational environment, strategy, technology, size and structure in a research setting
- Operationalize the concepts organizational environment, strategy, technology, size and structure
- Reflect upon the validity and reliability of data collected in a real-life company
- Measure and describe an organization in terms of the concepts organizational environment, strategy, technology, size and structure
- Analyze the compatibility between an organization's environment, strategy, technology, size and structure based on the theories selected
- Assess the effectiveness of an organization's structure based on the goal attainment, systems, and strategic constituencies perspectives on organizational effectiveness
- Systematically formulate an answer to a research question
- Provide recommendations in order to support organizational effectiveness to a real-life company

- Distinguish between empirical (descriptive, explanatory, design), conceptual and normative questions and is able to categorize a research question within these categories
- Identify units of analysis, units of observation, variables (and their attributes), the sign of causal relationships between dichotomous and ratio variables in scientific publications
- Assess and improve a conceptualization and operationalization of a concept by clarifying ‘dimension’, and by focusing on ‘precision’, ‘validity’ and ‘reliability’ of measurement
- Understand the basic idea of a ‘causal relationship’ (connecting it to both the ‘time order’, ‘association’ and potential ‘spuriousness’ of a relationship, and to the idea of ‘counterfactual reasoning’).
- Characterize ‘theories’ as providing ‘causal explanations’ as compared to ‘models’ and ‘concepts’
- Characterize four basic types of research designs (cross sectional, (interrupted) time series, experimental without pre-test and experimental with a pre-test) using the dimensions ‘time’ and ‘(comparable) groups’ and has a basic understanding of the possibilities and limitations to test causal relationships using these research designs
- Distinguish between random and non-random sampling, is able to distinguish between obtrusive (including interviewing and surveys) and unobtrusive (including text analysis and observation) methods of data collection and has a basic understanding of the threats to both validity and reliability of various data collection methods
- Present data (in a cross table and a scatterplot) and is able to perform an ‘elaboration’ in order to test a bivariate and a trivariate relationship using dichotomous variables both manually and by using SPSS (and is thus able to distinguish the main components of SPSS (menu, syntax file, data file, output file) and is able to use some of its basic commands)

- Characterize scientific research as systematically (methods) giving provisional (skepticism) answers to empirical research questions, is able to identify and contrast positivist and non-positivist models of knowing, and is able to relate 'research' to 'business decision making' (applied research, design methods)
- Know which ethical rules are seen as dominant in both 'doing science' (including no plagiarism, transparency of research, replicability), in dealing with research subjects (no harm) and in dealing with the consumers of research (secrecy of outcomes)

Content

The module is based on four knowledge domains: Technology, which is based on the principles of operations management; Organization, which is based on the principles of organization theory; People, which is based on the principles of organizational behavior; Research Methods, which is based on principles of social research.

Operations Management: after completion of the course, students should have introductory knowledge of the following operations management theories and approaches: transformation process, manufacturing and service technologies, departmental technologies and workflow interdependence.

Organization Theory: after completion of the course, students should have knowledge of the following organizational theories and approaches: scientific management, bureaucracy, strategic choice, open systems, contingency theory, resource dependency theory, stakeholder theory, organizational culture, organizational design and structure, including socio-technical designs.

Organizational Behavior: after completion of the course, students should have introductory knowledge of the following organizational behavior theories and approaches: motivation theories, communication, teams, and work design.

Research methods: after completion of the course, students should have a basic understanding of research methods to describe, analyze and design organizations, their people and their technology.

Project

The goal of the project is to describe and analyze a real-life company. In this project, students will describe an organization and analyze the fit between its organizational structure, technology, people, and other contingency factors, in to make an assessment of the effectiveness of the organization.

Next to the content-related challenges of this, the project-work contains some further challenges for students: working together in a multinational team, writing a structured report based on academic standards, present orally and in writing the results of their company description and analysis to peers, coping with different interests and conflicts, planning and controlling a project, cooperating with companies based on a shared code of conduct, understanding the needs and expectations of the customer, interviewing, coordination between groups of students.

The project report is based on two group assignments on which students get feedback during tutorials. Assignment 1: description of the real-life company based on its primary processes, description of materials and products, bureaucracy, sociotechnical systems, work design and financial performance of a company. Assignment 2: deepening of description of real-life company based on organization theory: organization structure and design, technology, size and environment. A preliminary analysis is made for the relationship between structure, environment, size and technology. Final assignment: analyzing the effectiveness of the company, given the relationship between different organizational contingencies. The final product of the course is a report with an integral description of the company and an analysis of its effectiveness.

Psychology in Learning & instruction – Psychology – Module 5

Learning goals

Theory component

After completing Part A of this component the student is able to:

- understand how people learn to read
- understand how people learn mathematics
- understand how people learn science
- understand how people (learn to) regulate their own learning process
- understand how information is best stored in and retrieved from memory
- understand how individual differences affect the learning process

After completing Part B of this component the student is able to:

- understand how instructional theories are rooted in behavioral, cognitive, and (social) constructivist approaches to learning
- understand the characteristics and effectiveness of expository forms of instruction
- understand the characteristics and effectiveness of collaborative methods of instruction
- understand the characteristics and effectiveness of authentic forms of instruction
- understand the characteristics and effectiveness of inquiry-based instruction
- understand the conditions for effective learning and instruction

Skills lab component

After completing Part A of this component the student is able to:

- know the purpose and application of psychological research methods and techniques in education.
- understand how the choice of psychological research methods and techniques depends on the researcher's questions and hypotheses
- understand how observations and student products can be used to investigate learning processes and learning outcomes
- prepare, conduct, and report on a structured observation to measure classroom management skills
- prepare, conduct, and report on artefact coding to measure learning outcomes

After completing Part B of this component the student is able to:

- understand the role and performance of basis didactical skills (e.g., explaining, questioning, giving feedback) in instruction.
- understand the role and importance of classroom management skills in delivering an effective instruction
- design a lesson plan in preparation of a 10-minute instruction designed according to one of the instructional theories addressed in Part B of the theoretical component of this module
- apply didactical and classroom management skills in delivering this instruction to a small group of learners
- analyze your own performance in this teaching-learning process through reflection

Project

After completing the project the student is able to:

- formulate learning goals and to make reasoned choices for instructional design theories to reach these goals
- transform goals and theories systematically into a design and prototype of an interactive learning environment
- perform and report on a small formative evaluation of the prototype
- cope with the difficulties in management of, and communication within a cooperative design project

Contents

In this module students will learn to understand the contribution and added value of psychology to education through a mixture of theoretical and practical coursework in which they alternately assume the role of student, teacher, researcher, and designer. The module consists of three components scheduled in sequential order. In the theory component students develop an initial understanding of how people learn and how instruction can promote the learning process while taking into account individual differences in age, cognitive development, and motivation as well as prevalent learning deficiencies such as dyslexia and dyscalculia. This theoretical knowledge is 'brought to live' in the skills lab where students will prepare and deliver a short instruction to their peers, and investigate the learning activities and learning outcomes in the lessons given by their peers. These theoretical and practical experiences are then used in the project where students will work in small groups on the design and evaluation of an instructional intervention. The choice for a particular topic, intervention, and group of learners is free to some extent, so students can follow their own interests.

Subjects & Exams

- Theories of Learning and Instruction
  Written exam + paper
- Research Skills
  Reports
- Teaching Skills
  Reports
- Instructional Design Projects
  Reports + prototype

Psychology of Safety – Psychology – Module 5

Learning goals

"At the end of the module, the student will be able to ….

- reproduce and apply psychological theories on the responses to physical safety, in particular technologies and industrial risks (Theory)
- reproduce and apply psychological theory on the potential impact of intervention strategies, communication and persuasive technology on the responses to physical safety issues (Theory)
- reproduce and apply psychological theory on the effect of the context on the responses to safety issues, in particular the physical environment and mass media coverage (Theory)
- analyse and diagnose situations of dyadic and interpersonal conflict and negotiations (Theory)
- reproduce the main elements of conflict management strategies as applied in dyadic mediation and online interventions (Theory)
- use psychological theory to explain the suitability of technological tools for conflict management and negotiations (Theory)
- reproduce and apply the most important concepts and mechanisms related to intra- and intergroup processes (Theory)
- reproduce the theoretical foundations of interventions aimed at mitigating intra- and intergroup conflicts and threats (Theory)
- use psychological theory to explain the suitability of technological tools for mitigating intra- and intergroup conflicts and threats (Theory)
- Use psychological theory to analyse and diagnose situations involving physical and social safety risks (R&D)
- Use psychological theory to design strategies to mitigate situations involving physical and social safety risks (R&D)
- Reflect on the mitigation of situations involving physical and social safety risks (R&D)
- Present a mitigation proposal in written and oral form (R&D)
- Design research aimed at the analysis and mitigation of situations involving physical and social safety risks (R&D)
- Reflect on the use of data collection instruments in a safety setting (R&D)
- Present research in written and oral form (R&D)

Content

Securing its citizens and infrastructure against disasters, terror/war, and crime is a central element of virtually every current society. This module focuses on understanding the (social) psychological dynamics of safety issues, particularly in the area of risk, conflict and deviant behaviour with the aim of developing effective interventions.

The module aims to provide insight into the psychological processes:

- shaping individual responses to risks and safety issues;
- ssociated with interpersonal and intergroup conflict;
- underlying group processes and crowd behaviour in the safety domain;
- surrounding societal interventions designed to enhance safety.

These themes are heavily affected by societal developments such as the growing need for resilient, adaptive citizens and communities as well as for citizens who actively engage in safety-related activities (e.g., community policing). Furthermore, awareness grows that many traditional interventions designed for safety-related incidents lack efficiency (and effectiveness). Therefore, there is a need for 'smart' and cost-efficient interventions.

Furthermore, technological developments are increasingly important for the psychological safety domain in three ways:

1. New technologies are usually accompanied by risk perceptions and aversion. We focus on how people perceive, make sense of and react to new technology-related risks (e.g. nano-modification of food).
2. Due to new technology, humans are more socially connected than ever before. This may not only increase the potential for (different types of) risks, conflict and crime (e.g., cybercrime), but also has a profound impact on emotions and cognitions, and on how people interact (e.g. social sharing). It also provides opportunities for implementing new technology-based interventions to change safety-related behaviours.
3. The rapid growth of technology allowing for the monitoring and analyses of physiological and behavioural responses of individuals and groups in real life contexts (through sensors, etc) creates innovative potential for the field of social psychology.

The module "Psychology of Safety" consists of two components:
a. Theory (lectures and exam training)
b. Research and Development (R & D; project meetings + presentation sessions)

"Theory" component
During the lectures, elementary psychological theories on responses to physical and social safety issues, and on intervention strategies in the safety domain will be put forward.
The lectures will build on the department's research that is conducted in collaboration with national and international partners such as law enforcement authorities, the Legal Aid Council, the National Crisis Center, various Ministries, and the Netherlands Food and Consumer Product Safety Authority.
The theory lectures will be supplemented by lectures of expert guests that illustrate the application of the theories in particular safety contexts. Examples are: interventions in legal conflicts; conflict management and bio fuel; internet, social media and (criminal) behaviour; risk psychology and persuasive technology. Two exam training sessions will be organized to familiarize the students with the type of questions on the exams.
The study material of this "Theory" component consists mainly of a selection of scientific articles. The references to this required readings will be provided on Blackboard.

"Research and Development" component (project)
This component will focus on the diagnosis and analysis of situations involving physical and social safety risks and the design of potential interventions to mitigate these. There will be 3 assignments and students will complete these in small groups. They will be required to report on their analysis and intervention orally and in writing.
The study material of this component consists mainly of the scientific articles to be studied for the exams, as well as scientific articles, reports and news coverage selected by the students themselves.

Subjects & Exams

- Theoretical models of societal safety
  Multiple written exams
- Research & design in safety contexts
  3 group assignments, including a presentation session

Consumer Products – Industrial Design – Module 6

Learning goals

The goal of the module is to introduce students to the complexities involved in the development of consumer products (products ordinarily bought by individuals or households for private consumption or use). Students are confronted with a large variety of subjects that collectively play a role in a development trajectory that is representative and typical for a consumer product. As multiple disciplines play important roles in the development of consumer products, the entire development cycle - from portfolio analysis, via market research to the presentation of mock-ups and manufacturability - is relevant in this module. Also questions related to priority, argumentation, reflection and project management play important roles.
To touch upon the 'real' complexities in product development, students participate in a development project with a factual problem formulation. This means that -each study year- a new problem is formulated in co-operation with a company (or organisation). The client (company) introduces the problem and reflects on the results at the end of the project. Where desired and possible, the company will also be involved during the project. To provide students with required knowledge, a number of workshops are included. Additional knowledge can be acquainted in three related module components.
To emphasise the realistic setting, students collaborate in multi-disciplinary project groups ressembling competing design bureaus. Each project group ideally consists of nine students, with an equal distribution over IDE, IEM and ME backgrounds. The students, besides having a joint responsibility for the project results, also have their individual responsibilities in other module components (which partially overlap for the IDE and IEM programmes). As an independent member of the project group, each student has, therefore, the responsibility to effectively and efficiently allocate the time available. To obtain the best possible project results, each student needs to contribute from his/her own field of expertise. It, however, also implies that not each student can be involved all the time. Consequently, students need to carefully plan their activities in such a way that the substantive input and the organisation of project activities are well attuned.

Project Consumer Products
After passing the course, the student can:

1. Apply a multi-disciplinary approach to product development problems
2. Transfer knowledge to people with different backgrounds (disciplines)
3. Re-formulate the problem specification by a client (formulate the 'real' assignment)
4. Select and set priorities in a plethora of relevant design aspects
5. Integrate and employ knowledge from different fields of expertise (like marketing, styling, CAD/CAM, intellectual property, packaging, production, research methodology, etc.)
6. Align different phases and perspectives on the product development cycle in respect to the cycle as a whole
7. Implicitly employ the knowledge and experience that is gained in previous modules
8. Concurrently pay attention to subject-matters and organisational aspects (project planning and management)
9. Present and market a product in an appropriate way

Technical Product Modelling 2
After passing the course, the student can:

1. Describe development processes and development phases in an interrelated manner
2. Describe and apply different methods and techniques (curves, surfaces and solids) that are used in CAD/CAM systems.
3. Describe possible ways to exchange data between different software tools (CAD, analysis, manufacturing) and select appropriate methods.
4. Describe and apply rendering techniques
5. Describe and apply modern methods and techniques in technical product modelling
6. Apply feature based modelling techniques and employ them to make doubly curved surfaces.
7. Build large assemblies in such a way that they can easily be adapted (e.g. in case of re-design)

Graphic Design
Introduction: This module part concerns the ordering of text and images, like photo illustrations, cards and other visual means in the 2D field. The focus is on printed graphical language, like business cards, posters, magazines, brochures, reports etc.

Content: The first two lectures focus on graphical language and typography rules. Subjects are: typograhical terms and systems, readability, different signs and symbols, use of colour, contrast. The following lectures focus on the applicability of the gained knowledge of the first lectures: creative aspects of graphical language in layout, choice of fonts and how to tell a story. These lectures are supported with short and long assignments to get familiar with composition, readability and usability.
The knowlegde of this module part can be used in other modules and projects: for instance when creating reports, folders, brochures, etc.

Instructional modes: This module part consists of lectures and self-tuition with guidance. All assignments must be executed and all assignments must be submitted at the feedback session. The assessment method is a "portfolio": all assignments will be assessed: the last assignment is the most important.

Attendance of the student is obligatory at the lectures, self-tuition with guidance and the feedback session. Use of laptop is also required.

Product-Market Relations
- describe core concepts of marketing, such as market orientation, customer value, and brand equity
- understand how marketing can help increase the odds of market success
- understand that the market success of product and services does not purely depend on design choices, but also on many other factors
- conduct and interpret market research, obtain insights in customer behavior, and design a marketing plan

Content

Project Consumer Products
The project in module Consumer Products challenges competing groups of co-operating students from different educational programmes to meet the multi-disciplinary project assignment by developing an adequate product while explaining and underpinning the product development cycle. The assignment is a realistic design brief, provided by an industrial partner. This company can also play a role in e.g. midterm reviews and project evaluation.
In the project, students 'Industrial Design Engineering', 'Industrial Engineering & Management' and 'Mechanical Engineering' conjointly participate in project groups; in principle, each project group exists of equal numbers of students of each discipline.
The project relies on the student groups to plan, manage and execute the development cycle, according to their explicitly stated priorities and focal areas. The project work is supported by a number of guest lectures, workshops and practicals.

Technical Product Modelling 2
Nowadays, computer tools are essential during the product development process (design and production processes). They integrate different processes in the product development process so that products are developed more effectively. This course pays attention to a number of aspects of the technical product development process. Also different advanced 3D modelling techniques are an important part of this course. The student becomes acquainted with methods and techniques which play an important role in CAD and CAM in mechanical engineering and industrial design engineering.

The course aims on the role of CAD in the product development process by looking at amongst others:
• design processes and types of design models;
• modelling of geometry like curves, surfaces or solids;
• storage, management and use of design data;
• exchange of product data;
• finite element analysis;
• design efficiency and the possibilities of different technologies.
The assignment focusses on modelling of complex assemblies, with a special focus on modular and flexible modelling so that assemblies can be redesigned quickly and easily. Also renderings, animations and simulations (strength/stiffness) are part of the assignment.

Graphic Design
After passing the course, the student can:

1. produce well designed and legible printed matter such as a report
2. provide graphic support for a product presentation
3. design product information such as usage, safety, and legal aspects
4. communicate and collaborate with professional graphic designers

Product-Market Relations
This course is aimed at teaching students the fundamental basics of marketing and introduces some relevant models and analysis techniques used in new product development and -introduction.

The following topics are covered:
• Strategic Marketing
• Marketing Research, Consumer Behavior, Segmentation & Targeting
• Product & Service Management
• Price Management
• Distribution Management
• Marketing Communication

Subjects & Exams

- Project Consumer Products
  Assignment, Presentation & Verbal Exam
- Technical Product Modelling 2
  Assignment & Written Exam
- Product-Market Relations
  Written Exams & Assignments

Dynamical Systems – Applied Mathematics – Module 6

Learning goals

After following the module it is expected that a student:

1. Knows if a solution of an ordinary differential equation (ODE) exists, and whether it is unique.
2. is able to solve ODEs analytically using separation of variables, or matrix-exponentials for linear in homogeneous first order systems.
3. Can determine equilibria and analyse their stability using linearisation or Lyapunov functions
4. Can classify solutions for planar systems using nullclines, conserved quantities and the theorem of Poincaré-Bendixson.
5. Is able to determine whether a system is linear, time-invariant or causal, and understands the notion of a state. And in case of a linear system, whether it is controllable, observable, stabilisable and detectable.
6. Is able to design an observer and stabilizing controller based on a state description of the system.
7. Can determine and analyse transfer functions of a complex system and use them to design stabilising controllers.
8. Is able to adapt analytical problems into numerical algorithms and implement these in Matlab.
9. Can interpret results from a numerical algorithm using error analysis.
10. Is able to formulate mathematical models for basic (physical) systems and investigate their behaviour using knowledge of the courses.

Contents

Differential equations are used in many applications such as population dynamics, mechanical systems, electrical circuits, climate dynamics and weather forecasts. These are dynamical systems whose solutions depend on time and/or space. We study the behaviour of the solutions and the system. In this module we study differential equations from various perspectives. Whenever possible, we will determine their solutions explicitly and analytically. If not, we wtill investigate their geometrical properties or approximate them numerically. In the latter case, we want to know how accurate the result of the numerical procedure is. This knowledge may also enable us to steer a solution to a desired state. In a modelling project, students will create their own system and investigate it using methods from the courses.

In the course “Differential Equations” we first treat theory and solution methods for first order, scalar ODEs and linear systems. Here we will classify (planar) equilibria. Subsequently we consider (in)stability of equilibria as a preparation for the study of nonlinear systems. We treat linearisation near equilibria, and some elementary bifurcations. For systems in the plane we classify the asymptotic behaviour using the theorem of Poincaré-Bendixson. This enables to prove the existence of periodic orbits. Finally, we introduce conserved quantities and Lyapunov’s method for stability.

In the course “Systems Theory” we provide a discourse on several results from Systems and Control Theory. The focus is on dynamical systems with inputs and outputs, especially for linear systems and their state representations. An important problem is the extent to which the dynamical behaviour can be controlled by choice of input.. In contrast to ODEs where solutions may be unstable, we may be able to turn unstable ODEs into stable ones by carefully choosing the input. For this type of analysis, we need the notions of controllability, detectability and observability. We design observers to estimate the state of a system. Finally, we analyse systems in the frequency domain and construct controllers using transfer functions.

In the course “Numerical Methods” we treat discretisation and iterative methods for mathematical problems to solve these using a computer. Importantly, every method will yield numerical error due to round off and approximation. Estimating numerical error and minimizing computational cost, requires reliable extrapolation and efficient implementation. The course consists of six blocks addressing six pivotal themes: error analysis, quadrature, data fitting, numerical solutions of ODEs and boundary value problems, and partial differential equations.

The courses discuss the methodology for solving particular problems. This is also prominent in the project. Moreover, a deeper understanding and mathematical foundation for some topics is discussed in “Capita Selecta”. For instance, we discuss existence and uniqueness of solutions, iterative methods and convergence of discretisation schemes and the notion of state. There is a “Challenge of the Week” related to the theory and the methods that were studied in a particular week. This challenge is discussed in an open and informal manner, giving a central role to the students

Voorkennis

Basic knowledge of calculus and linear algebra (eigenvalues and vectors) is assumed. Some experience in matlab and/or programming is useful.

(additional) requirement(s) for minor students: UT Mathematics Track (first year) and basic knowledge of Matlab or contact the AM bachelor coordinator.

Subjects & Exams

- Differential Equations & Numerical Methods
- Systems Theory & Numerical Methods
- Practicum Numerical Methods
- Project

Materials Science & Engineering – Advanced Technology – Module 6

Learning goals

The student can:

a. calculate diffusion processes in solid and crystalline materials, the value of a characteristic parameter (saturation magnetization, polarization) by simple models, apply Weibull statistics to evaluate fractures in materials.

b. explain binary phase diagrams of metals and oxides and the influence of thermodynamics and kinetics of phase transitions on the microstructure.

c. regarding the properties of materials: determine the material class by a global description of its properties (electrical, magnetic) , and provide for a specific, technological material:

   1. a description of all primary mechanical and functional properties (magnetic, electrical, optical, etc.).
   2. an explanation of the properties on the structure, taking care of the fact that different phenomena at different length scales play a role.

d. explain the relation between properties, structure/composition and synthesis for inorganic materials; Explain epitaxial growth and strain within materials.

e. describe the principles of the commonly used physical vapor deposition techniques and chemical vapor deposition techniques for films; describe the principles of sol gel and sintering techniques for bulk materials.

f. apply, for a particular practical situation of a functional material in an actual device, the separation between function, properties and fabrication requirements.

g. describe the central ideas in colloid science (like surface energy, adsorption, wetting, surface potential, electro-osmosis, electrophoresis and colloidal stability); the central ideas in transport of the reactants/products to/from the catalyst (Molecular and Knudsen diffusion, internal and external mass transfer limitations, Thiele modulus); the assumptions of Langmuir-Hinshelwood and Eley-Rideal mechanisms.

h. in analyzing experimental data, find kinetic parameters; describe and interpret results from important characterization techniques (chemisorption, electron microscopy, STM, XRD, XPS, LEED); and use expressions for capillary rise / pressure, adsorption isotherms and electrical double layers.

i. predict the apparent activation energy for a catalyzed reaction in the case of no/ internal/ external mass transfer limitations.

j. explain the following concepts: energy band diagrams and their importance for devices; the drift-diffusion equations; recombination; "depletion approximation" and charge conservation; threshold voltage.

k. explain the formation of the pn-junction diode at thermal equilibrium, the rectifying behavior of the pn-junction diode, the formation of the MOS capacitor at thermal equilibrium.

l. model the current flow through the pn-junction diode in steady state condition, and the current flow through the MOSFET in steady state condition and apply Gauss' law in a semiconductor for determining the electric field/potential.

m. explain the advantage of using semiconductor devices in microelectronics and evaluate the limiting factors in electrical performance of classical semiconductor devices and come up with possible improvements.

Contents

In any device whether this is an electronic transistor, solid-state battery or a gas sensor, several properties of different materials are combined to achieve a desired functionality. The objective of the module Materials Science and Engineering is to get the student acquainted with the relation between basic properties of materials and their functional application. This includes obtaining knowledge of the direct connection between material properties, structure/composition and material synthesis. At the end of the course, the student should be able to describe the functional properties of materials used in a specific device and be able to connect these to basic material properties in relation to the ability to synthesize these materials.

The module consists of a general part in which first the relation between the functional properties of materials and the microstructure is discussed; subsequently the relation between the microstructure and specific synthesis techniques is studied. The second part is an elective part of either a chemistry track course that focuses on the effects of interfaces in materials with emphasis on catalytic reactions, or a physics track course that focuses on charge transport in semiconductor devices.

Voorkennis

Introduction to Quantum mechanics (wave-particle duality, Schrodingers equation, Heisenberg's uncertainty relation hydrogen atom, free electron model, basic band theory of solids)
Introduction to materials science (Structure of materials on different length scale, periodicity in crystalline materials, reciprocal lattice and miller indices, relation between structure and material characteristics)

(additional) requirement(s) for minor students: Basic knowledge of Materials Science.

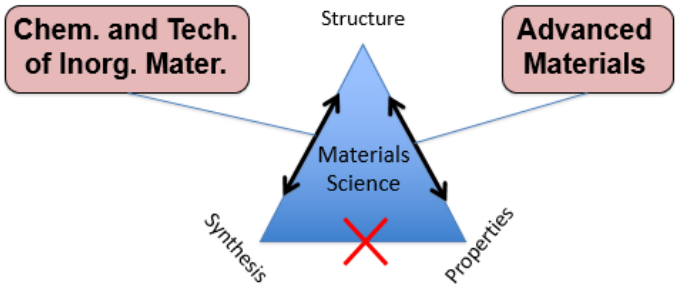
Subjects & Exams

- Advanced Materials
  Report & written exam
- Chemistry and Technology of Inorganic Materials
  Report & written exam
- Physical Chemistry of Interfaces (Chemistry track)
  3 Written exams & practical
- Semiconductor Devices (Physics track)
  Report & written exam
- Chemistry and Technology of Organic Materials
  2 written exams

Personal Experience – Lieke van Ginkel - Materials Science and Engineering

Omdat ik nu in mijn derde jaar zit (2017-2018), mocht ik het eerste deel van het jaar een minor volgen. Ik heb de minor leren lesgeven gevolgd in het eerste kwartiel van het jaar en in het tweede kwartiel van het jaar (module 10) heb ik de minor Materials Science and Engineering gevolgd bij AT. Deze kan je nu in principe ook volgen bij ST, in module 8, maar ik had ervoor gekozen om toen de procestechnologie module te doen.

Tijdens de minor had je drie vakken en een project. De vakken waren Advanced Materials, Chemistry and Technology of Inorganic Materials (CTIM), Chemistry and Technology of Organic Materials (CTOM) en het project ging over de toepassing van Advanced Materials en CTIM in een case. Ik moest de vakken samen met mijn groepje toepassen op een materiaal voor een ''microstate battery for medical application''.



Figuur 1: Samenhang in de materiaalkunde [1]

Materiaalkunde onderzoekt de samenhang tussen drie factoren, zoals in Figuur 1 staat weergegeven. Het vak Advanced Materials behandelt de samenhang tussen de structuur en de eigenschappen van een materiaal en het vak CTIM behandelt de eigenschappen tussen de synthese en een structuur van een materiaal.

Advanced Materials is echt een materiaalkunde vak. Het gaat dieper in op de eigenschappen van een materiaal (bijvoorbeeld de elektronische eigenschappen) en het linkt de invloed van een bepaalde structuur aan de eigenschappen van het materiaal. Zelf vond ik dit het moeilijkste vak van de minor. Dit omdat het veel informatie was en niet duidelijk was wat je precies moest weten en wat minder relevant was. Hierdoor was je aan dit vak ook de meeste tijd kwijt. Het voordeel van het vak was wel dat hoe meer je jezelf erin verdiepte, hoe interessanter het werd. Een advies voor Advanced Materials is wel om echt de opdrachten te maken, omdat je hierdoor toch een beetje in de gaten krijgt wat je moet weten en wat niet (al blijft het vaag).

CTIM behandelt de koppeling tussen de synthese methode en de structuur van het materiaal. Het was op zich interessant om te leren, maar het was weer heel veel informatie en de week voor het tentamen moest je veel leren (stampen), omdat het handig was om de technieken uit je hoofd te weten. Het is ook praktisch om voor dit vak alle colleges te volgen, want er zijn geen opgaven bij en de slides zelf zijn niet super informatief.

Het leukste en beste vak deze module was zeker weten CTOM. Het was gesplitst in een chemisch en fysisch deel, toegespitst op polymeren (wat ik erg leuk vond). Het chemische deel was een beetje herhaling, door eerdere vakken over polymeren in voorgaande jaren. Het fysisch deel was nieuwer en vooral veel rekenwerk en minder leerwerk. Dit vond ik erg leuk. Daarnaast werden de colleges gegeven door Hempenius, wat sowieso al een plus is. Wat ook heel goed werkte, was dat je tijdens het college zelf al opgaves maakte, waardoor je als je thuis was niets meer voor CTOM hoefde te doen. Je had wel de optie (dus niet verplicht) om huiswerkopgaven te maken, die meetelden als bonus voor je eindcijfer (per deel een half punt erbij op je eindcijfer) wanneer je ze inleverde. Wat fijn was, was dat je antwoorden niet goed hoefden te zijn, als het maar zichtbaar was dat je er moeite voor had gedaan en je door deze opgaven natuurlijk makkelijker een hoger cijfer kon halen. Over het algemeen is CTOM relatief makkelijk.

Het project was een beetje vaag, omdat het voornamelijk literatuuronderzoek was en ook omdat de docenten voor elk deel (CTIM en Advanced Materials) een beetje tegenstrijdige eisen leken te hebben. Uiteindelijk heb ik het wel relatief goed afgerond. Het project cijfer telde mee in je eindcijfer voor Advanced Materials en voor je eindcijfer van CTIM. Het was zo ingedeeld dat je iedere week 1 à 2 pagina's aan informatie over je materiaal moest inleveren, waar je de volgende week dan feedback op kreeg. Je had hiervoor per week sowieso 2 ingeroosterde uren, waar je ook vragen kon stellen aan de docenten. Het klinkt heel naar om iedere week een deadline te hebben, maar het was eigenlijk heel fijn, omdat je hierdoor niet het project kon uitstellen tot het allerlaatste moment. Op moment dat je dan echt je project moest afronden had je al een heleboel informatie. Wel was het vreemd dat we ruim twee weken voor de module eindigde het project al ingeleverd moesten hebben. Het project was ook enigszins saai, doordat je enkel maar literatuuronderzoek aan het doen was. Wat wel leuk was, was dat je gebruikte wat je in college had geleerd.

Qua tijdsbesteding is dit een chille module. Ik had nog nooit eerder zo'n rustige module meegemaakt (behalve nu module 11 misschien). In de eerste twee jaar bij ST heb je best wel veel college en een aardig vierkant rooster. Dat is bij deze module niet het geval. De meeste opdrachten kan je gewoon tijdens de colleges zelf maken, bijvoorbeeld en ook het aantal contacturen was relatief weinig. De enige echt drukke momenten gedurende deze minor ondervond ik rond een week voor een tentamen. De vakken zijn namelijk echt stampvakken, want je moet veel informatie uit je hoofd weten. Deze module was niet moeilijk, maar vooral anders. Waar het bij ST over het algemeen draait om inzicht, formules en berekeningen, is deze module echt een leermodule, met veel stampwerk. De module is goed haalbaar, maar om je tentamens te halen moet je er wel tijd in stoppen.

De aansluiting van deze module op ST is te vinden aan de materiaalkunde kant. Deze module (of de soortgelijke module gewoon bij ST) moet je namelijk hebben gevolgd als de je in de master de materiaalkunde track wil doen. Het nut van deze minor ligt dus ook voornamelijk in de voorkennis voor de vakken in de master. Als je de procesmaster wil gaan doen, en echt niets met materiaalkunde hebt, dan zou ik deze module niet aanraden. Misschien is het soms nuttig om te weten welke synthese methodes er zijn om een bepaalde structuur te krijgen, zodat je weet welke reactor je nodig hebt, maar dat zou je feitelijk ook gewoon kunnen googelen.

Een uitdaging binnen deze module is wel om te blijven opletten tijdens de colleges, omdat het relatief saai is, gezien het vooral luisteren en informatie verwerken is.

Kortom: Volg deze module vooral als je geïnteresseerd bent in materiaalkunde (of nog niet weet welke kant je op wil) en als je er blij van wordt om niet super veel te doen, tenzij er een tentamen nabij is (en je niet vies bent van stampwerk).

Groetjes,

Lieke van Ginkel

[1] Mark Huijben, CTIM hoorcollege 1, november 2017

Public Governance in Europe – European Public Administration – Module 6

Learning goals

Na afloop van deze module is de student is staat om:

- Wetenschappelijke teksten te schrijven over een kwantitatieve studie
- Wetenschappelijke teksten kritisch te beoordelen
- Relevante onderzoeksvragen te formuleren met betrekking tot de relatie tussen openbaar bestuur en sociale ongelijkheid
- hierbij specifieke hypothesen af te leiden uit algemene theorieën over ongelijkheid
- Voor de geformuleerde onderzoeksvraag relevante gegevens over landen te gebruiken
- Hypothesen te toetsen met behulp van regressie analyse
- Conclusies te trekken op basis van de uitkomsten van regressie modellen, en de bevindingen te rapporteren
- En theoretische verwachtingen en empirische resultaten mondeling te presenteren aan mede-studenten en docenten

Contents

In deze module maken studenten kennis met alle aspecten van het doen van empirisch onderzoek binnen de bestuurskunde. In drie geïntegreerde module onderdelen volgen studenten de hele empirische cyclus. De kern van de module wordt gevormd door het project *Governance and Inequality in Comparative Perspective*. In dit project schrijven studenten in groepen een onderzoekspaper waarvoor ze de gehele onderzoekscyclus doorlopen (Achtergrond, Probleemstelling, Theorie en hypothesen, Data en Analyse en het Rapporteren van onderzoeksbevindingen). Het onderzoekspaper richt zich op de effecten van (democratische) instituties op sociale ongelijkheid. Het onderzoek is daarbij vergelijkend van aard (d.w.z. een vergelijking van landen), en richt zich hoofdzakelijk op verschillen en overeenkomsten tussen geavanceerde kapitalistische democratieën binnen en buiten Europa.

In het project bouwen studenten voort op de contentselijke input uit twee andere moduleonderdelen. In het eerste onderdeel worden studenten geïntroduceerd in de belangrijkste vragen, theorieën en onderzoeken met betrekking tot sociale ongelijkheid. In dit disciplinaire onderdeel, *Inequality in Multidisciplinary Perspective* ligt de nadruk op relevante onderzoeksvragen, belangrijke hypothesen en meetinstrumenten in de economie, sociologie, politicologie en rechten. Ook komen in dit onderdeel de effecten aan de orde van verschillende (democratische) instituties op de mate van ongelijkheid in landen. Het tweede onderdeel is *Applied Linear Regression*. In dit onderzoeksmethoden deel leren studenten de relevante vaardigheden en software om antwoord te geven op de onderzoekvragen die ze in het project hebben geformuleerd.

(aanvullende) ingangseis(en) voor minorstudenten: Basiskennis over social research methods

The Privacy Paradox – Communication Studies – Module 6

Learning goals

At the end of this module, students are expected to be able to:

1. describe the mechanisms behind people's privacy-related behaviors;
2. explain the need to protect and the issues related to online information privacy from ethical, legal, and technical standpoints;
3. discuss the ways various technologies can be used to both violate and protect online information privacy;
4. understand and use the various methods and software currently available for analyzing various types of online information; and
5. apply the knowledge they have acquired from the theoretical and practical discussions of privacy into the production of a documentary film to influence the ways people deal with their online information privacy and their general attitude towards online information privacy.

This module aims at enabling students acquire a thorough understanding of the behavioural, ethical, legal, and technical aspects of online information privacy. Students will also acquire useful skills for analysing structured and unstructured data that are accessible in the digital environment. The theories and skills that students will acquire from the sessions, workshops, individual readings, and group discussions will then be used to produce a video-based intervention, specifically in the form of a documentary film.

This module includes four components:
2.2 **P**roject: Promoting Privacy Protection Behaviour
2.2 **T**heory: Online Communication and Privacy
2.2 **R**esearch Methodology: Big Data Analytics
2.2Academic and Professional **S**kills: Audio-Visual Design

2.2 P: Promoting Privacy Protection Behaviour
For this module, students will design and produce a video-based intervention, in the form of a documentary film, to either increase people's awareness of the risks of online information disclosure (either voluntarily or involuntarily) or to inform them of ways to safeguard their information privacy online. For the intervention design process, students will focus on a very specific risky online transaction (e.g. internet banking, online social networking, downloading mobile apps) and clearly identify a privacy-related issue or problem to be addressed.

Specifically, students are expected to (a) engage in an in-depth analysis of a specific issue that they will focus on for their documentary film, (b) identify the target audience for the documentary film (e.g. minors, professionals, senior citizens), (c) determine their level of awareness of information-privacy violations online and their knowledge of relevant privacy protection strategies, and (d) produce a documentary film using results of a small-scale study with the target audience coupled with relevant points on online privacy behaviour from the literature.

Given the final product for the module project, students will be provided with opportunities (in the form of workshops) to acquire skills in writing scripts for documentary films and in producing documentaries of professional quality.

2.2 T: Online Communication and Privacy
This module component will address the topic of online communication and privacy from four different perspectives, namely (a) behavioural, (b) ethical, (c) legal, and (d) technical. Each perspective on privacy will be thoroughly discussed in small-scale courses that will be taught by a content expert or thematic researcher.

For the behavioural aspect of privacy, the discussions will concentrate on the interplay among trust, risk perception, and the individual decision to either safeguard or compromise one's information privacy in the online environment. This component of the 6 EC course will also look into the nature of the privacy paradox.

For the ethical aspect of privacy, the primary focus will be on the ethical and the moral bases for the individual right to privacy. Furthermore, the discussion will also tackle the tension between an individual's claim to privacy and the communitarian need for transparency and openness.

For the legal aspect of privacy, students will have the opportunity to understand institutional efforts to safeguard citizens' personal data, and subsequently their right to privacy. During the sessions, the critical role of the European Union's General Data Privacy Regulation (GDPR) in protecting EU citizens' information privacy will be discussed in depth.

Finally, for the technical aspect of privacy, the sessions will deal with the ways current forms of technologies are utilized to both violate and protect people's privacy when they are engaged in various activities in the digital environment.

2.2 R: Big Data Analytics

A wealth of information is available from websites, forums, and social media. Big data analytics are increasingly being applied to combine data from various sources, to represent the outcomes graphically, and to generate new knowledge about individuals based on information that is publically available. Knowledge about the practice and potential of big data analytics will enable the students to develop a video-based intervention about people's awareness of the risks of online information disclosure (voluntary or involuntary) or to inform them of ways to safeguard their information privacy online. In this module component, students will be introduced to the field of big data analytics. They will study the methods and the software that are available for analysing online information. Examples of the use of big data analytics will be studied and the strengths and weaknesses of the methods used will be discussed.

2.2 S: Audio-Visual Design

To support the final project for this module, workshops on scriptwriting for video documentaries and on producing video documentaries will be scheduled. During the workshops, students will be introduced to the three phases of video production, namely (a) pre-production which involves research, case analysis, and goal specification, (b) production which involves scriptwriting, storyboarding, and shooting, and (c) post-production which involves video editing.

Deepening Minors

Smart Cities – Muticunctional Flood Defences – Civil Engineering – Module 9

Learning goals

Students are able:

1. To provide an overview of Multifunctional Flood Defences, their users, functioning and practical challenges in designing
2. To explain the functions and requirements for the preliminary design
3. To explain and apply state-of-the-art knowledge on one topic of the design of a multifunctional flood defences.
4. To integrate their state-of-the-art knowledge into the design of MFDs within an interdisciplinary team
5. To present and visualize the final design using a (physical) model
6. To implement their expertise in an interdisciplinary team

Content

In this module students will create and design a Multifunctional Flood Defences as an innovative solution for Smart City planning. Students will master learn in-depth knowledge related to MFDs and apply this knowledge in an interdisciplinary design and co-create a physical scale model for the study area.

Under the increasing pressure of growing population, urbanisation and climate change, the worldwide number of citizens threatened by floods is increasing. This increase puts pressure on the use of space in deltaic regions – where roughly 40% of the global population nowadays live – all around the world; there is an urge to effectively use the available space along coasts and rivers. Multifunctional flood defences increasingly raise interest as a solution in many regions around the world (e.g. New York, Japan and the Netherlands). Compared to conventional flood defences, an increasing number of design requirements needs to be considered for MFDs, such as its use functions, spatial planning, flood safety and location specific environmental characteristics, with an associated increasing number of actors. In this module, students are introduced to the opportunities and challenges in Smart City planning for flood protection. This module teaches integration of knowledge from various scientific fields, addresses interdisciplinary co-creation and combines it in a practical design project. Students are asked to go in-depth in their own scientific field, while integrating their results in interdisciplinary teams. The final product of this module is a design of a MFD for the study area for which students will also create a physical visualization in the form of a scale model.

In this module, students learn to integrate knowledge from various scientific fields, learn to design in an interdisciplinary team and learn to use expert knowledge to create a physical scale model of a Multifunctional Flood Defence. Four state-of-the-art topics, essential for MFD design, are introduced. Students go in-depth into one of these topics, while integrating their results in interdisciplinary teams.

1) Dynamic use functions, as these need to be analysed to be able to match the final design to the wishes of various actors including future changes.
2) Stakeholder and knowledge management is an essential component of highly complex projects. The objective of this aspect is to develop a strategic plan that outlines objectives and means for: dealing with stakeholder interests, integrating knowledge from experts and stakeholders and communicating and disseminating your innovative design.
3) Spatial Subsoil Planning. Constructions, such as houses or parking lots integrated in the flood defence require knowledge of suitable building locations regarding spatial planning of the subsoil.
4) Novel Building with Nature concepts, such as vegetated foreshores can be applied to combine nature and flood safety.
5) Multifunctional Flood Safety poses challenges for the methods for assessing flood safety, which is affected by transitions between dikes and embedded structures. Students apply novel methods to ensure safety against flooding.

The study area is divided into sections of around 1km length. Each team consists of five students and is responsible for the design of one of the neighbouring sections of the study area. Each team member works as an expert on one of the four topics and acquires in-depth knowledge. The experts from the different teams work together to exchange knowledge and learn from each other under supervision during expert meetings. During plenary sessions, the designs and requirements are exchanged between the teams. The DesignLab will be used as a central location for lecture, exchange, project work and physical model construction. Planning of the design and work process is essential in this module.

Subjects & Exams

- Preliminary Design
  Report
- Team Project
  Report + Assignment
- Individual project
  Report
- Visualization of Design

Lab on a Chip – Electrical Engineering – Module 10

Learning goals

To have the students understand, design, make and measure with a lab on a chip system for a real-life measurement problem.

Content

The Lab on a Chip course will give the students the experience of working in a multidisciplinary development team composed of students from different study programs. They will develop a real-life Lab on a Chip system, in this development making the full *design circle* (design, build, and measure) to solve a real-life measurement problem using Lab on a Chip technology. The course will make the students also acquainted with state-of-the-art prototyping techniques such as polymer molding and 3D printing. The course will furthermore teach students how to properly perform a measurement and how to interpret measurement data.

In a series of 11 problem-based learning session the students will activate their preexisting knowledge or acquire new knowledge on a range of subjects that are particularly relevant for labs on a chip. These problems concern the fields of fluid mechanics, mass transport, prototyping and micromachining, electrochemical and optical sensing and measurement methods. Simultaneously they will train the necessary lab skills such as chemical and biological lab skills (culturing) and prototyping lab skills. The main part of the course is formed by the project work, where the students from the start on will be working in 4-person interdisciplinary teams. At the start of the course they will be divided into groups and every group can choose its own project from the list offered. During the module they will first make a problem plan, then design their Lab on a Chip, make it and measure with it. Oral presentations and written reports are ways of assessment during the project in the planning, design and final reporting phase.

Subjects & Exams

- Diagnostic test (multiple choice, digital)
- Problem based learning assignments
- Lab and fabrication skills
- Project plan
- Project plan presentation
- Project design
- Project report
- Project presentation
- Final exam

Personal Experience – Amarna Pels – Lab-on-a-Chip

Ik heb de minor Lab-on-a-Chip gevolgd in het tweede kwartiel. Ik heb deze minor gekozen, omdat het me een leuk onderwerp leek. Het idee van processen op microschaal uitvoeren heeft mij altijd al aangetrokken en het samenwerken met andere opleidingen leek mij er interessant. De minor is niet echt opgedeeld in vakken, maar in theorie en project. In plaats van hoor- en werkcolleges krijg je problem-based learning sessions (PBL's) waarin iedere keer een ander aspect van Lab-on-a-Chip wordt behandeld. Je krijgt een probleem waar je, aan de hand van gegeven en zelf opgezochte literatuur, een oplossing moet bedenken. Je wordt hiervoor in groepjes opgedeeld gebaseerd op je achtergrond, dus je hebt meerdere expertises binnen de groep. Als jij het niet weet, weet een ander het vaak wel. Deze manier van stof krijgen beviel mij goed, maar het was wel vermoeiend. Je begint 's ochtends vroeg en bent dan tot het einde van de dag bezig. Het voordeel van deze manier van lesgeven is dat je direct met de stof aan de gang gaat. Doordat je dat doet hou je vaak de informatie beter vast en als je een fout maakt, blijft die vaak bij je. Het nadeel is, is dat er weinig literatuur is om van te leren terwijl je naar de toets toe werkt. De PBL's gaven altijd een lijst met dingen die je zeker weten moest leren en door gewoon goed op te letten bij de bespreking van de PBL's kon je de rest ook goed binnen krijgen.

Het andere deel is het project. De projectgroepen waren ook weer ingedeeld zo dat er studenten van meerdere opledignen in een projectgroep zaten en zo meerdere expertises. Aan het begin vand e module werden de projecten gepresenteerd en kon zelf keizen welke je wilde. Het doel was om een chip te ontwerpen en fabriceren die jou toepassing kon uitvoeren en kon analyseren of het proces daadwerkelijk plaatsvond. Je moest zelf het lab op om deze dingen te doen. Eerst onder begeleiding, maar daarna zelfstandig. Iedere week was er een meeting met de begeleiders om te zien hoe het gaat en waar er nog knelpunten zijn om aan te werken.

Ik kan met gemak zeggen dat dit mijn favoriete project is dat ik heb gedaan. Dat je zelf je onderzoek moet opstellen was in het begin wat eng, maar toen ik eenmaal aan de gang was, liep het heerlijk. Het was niet de bedoeling van het project dat je een volledig functionele chip kreeg die alles doet wat ervan gevraag werd, maar dat je onderzoek doet naar het maken van een chip die aan alle eisen voldoet. Het mislukken van een experimenten kon alleen een slechte beoordeling krijgen als je niet kwam met antwoorden waarom het mis was gegaan en wat eraan verbeterd kon worden.
De begeleiding was ook heel goed en gaf goede hints aan wat je nog verder kon doen, maar liet ons vooral ons eigen ding doen.

De tijdsbesteding was anders dan normaal. Door de PLB's hand je geen huiswerk om thuis te doen en het waren meer 11 dagen. De rest van de dagen waren voor het project en die hand je ook echt nodig. Ik heb zelf meer dan 2 weken op het lab door gebracht om experimenten te doen en de rest van de tijd was besteed aan het analyseren van resultaten en bedenken wat de volgende stap was. Het is iets zwaarder dan ST overdag, maar in ruil daarvoor hoef je weining tijd 's avonds te besteden.
De aansluiting met ST is goed. De meeste onderwerpen die behandeld zijn in de PBL's zijn al een keer behandeld in vorige modules, alleen dan met de aanpassing dat het gaat over µm in plaats van m. Het enige echte nieuwe was het kweken van celculturen. De PBL's waren opgezet zo dat als je het niet wist, iemand in jou groepje het wel wist en je dus zo kennis uitwisselt. Hetzelfde geldt voor het project. Als ST'er weet je wat de correcte omstandigheden voor een bepaalde reactie is, maar iemand van EE weet dan waar je rekening mee moet houden als je electrodes hebt en een BMT'er weet hoe je dan je gistcellen levend houdt. Elk lid van je project of PBL groep vult de gaten in de kennis van een ander op en zo kom je uitendelijk tot een antwoord

Groetjes,

Amarna Pels

Serious Gaming – Technical Computer Science – Module 9

Learning goals

Students are able to:
- apply game design methodologies;
- apply game mechanics;
- apply the SCRUM project management methodology;
- provide structured feedback;
- work in multidisciplinary teams present projects during poster presentations.

Content

The Serious Game Design Module provides students with a theory driven play centric approach to serious game design. This course does not need programming skills and will focus on design. During the module groups of students will develop, play and validate a serious game. The developed games should have an instructional value in other courses within the University of Twente, or have an added value for external partners. Domains are (but are not limited to) health, logistics &retail, business processes, psychology and game development itself. During the Serious Game Design Module two parallel tracks co-exist: the serious game design project and a theoretical serious game design track both following a cyclic model (Figure 1):

1. Apply Business Modeling Theory, Create BM for serious games, experiment, and reflect.
2. Create, Play, Reflect of a Serious Game in one application domain:

1. Logistical game theory, play a supply chain game, create, play and reflect on logistic applications of gaming &simulations.
2. Health game theory, play obesitas game, create, play and reflect on health app's.
3. Investigate entertainment gaming domain, play a music learning game, create, play and reflect on entertainment domain.
4. Safety game theory, play disaster game, create risk management and reflect.

*Formative assessments*In week 3-5-7-9 formative assessments take place during the sprint reviews (progress presentations). Feedback will be provided by peers and teachers as well as professional game designers (week 5 jury review). The feedback will be gathered and presented to the student with the use of gamification techniques enhancing between group competition and motivation. Groups collect points by scoring higher on the sprint assessment criteria and earn badges when milestones are reached. The results will be displayed on Blackboard, enabling social comparison as a motivator. Within the module game mechanics are used to motivate and monitor students' achievements.*Normative assessment*The outcomes of the project track is used as the main normative assessment for the Serious Game Design Module. The final grade for the project track will be composed out of the following elements:

- 20% Quality of the game / game presentation (poster market);
- 70% Quality of the game design documentation;
- 10% Quality of SCRUM logs.

Individually the players have to play a serious trivial pursuit and pass this game

The game design documentation provides the rationalization and theoretical underpinnings of the iterative (agile) game development process. The quality of the game and the presentation of the final game is assessed during the poster market to potential product owners. Finally since the correct application of SCRUM is a secondary goal of the course, quality of the logs is assessed.

Subjects & Exams

- Game quality and game pitch
- Game and game design documentation
- Game design project management

Cyber-Physical Systems – Electrical Engineering – Module 10

Learning goals

The learning goals for the various mini-tracks are as follows.
(1) Formal specification and hybrid systems:
After this module the student is able to:
1. understand the fundamentals of Timed Automata (TA)
2. understand the use of model checking in the tool UPPAAL
3. use TA and UPPAAL in the analysis and design of real-time systems
4. understand the fundamentals of Statistical Model Checking (SMC)
5. use UPPAAL SMC for analyzing simple hybrid systems

(2) Sensor and actuator systems
After this module the student is able to:
1. Describe and explain main design principles behind WSN systems, protocols and algorithms.
2. Describe and explain mechanisms to be used to achieve distributed and self-organizing capabilities at various layers of an WSN architecture.
3. Describe in detail how some well-established WSN systems, protocols and algorithms function, and describe their strengths and weaknesses.
4. Use critical thinking skills to develop alternative strategies for solving WSN problems.
Study material: reader/download with (links to) research papers.

(3) Dependable system and network design and evaluation:
After this module the student is able to:
1. Explain the concepts of dependability and the basic principles of dependable system design;
2. Explain and apply simple redundancy mechanisms to improve system dependability;
3. Explain and apply basic techniques to evaluate system dependability, such as reliability block diagrams, fault-trees and Markov chains;
4. Explain and apply the basic principles of highly-dependable storage systems;
5. Discuss key developments (from an historical perspective) in fault-tolerant system design;
6. Use state-of-the-art tools for evaluation system dependability (for example, Möbius or PRISM).
Study material:
- Scientific paper and chapters on the above topics;
- Slides.
Activities: Lectures and tutorials, using software running on the student's own laptop.
Assessment: take home exam.

(4) Real-time operating systems.
After successful completion the student can:
1. To be provided
Study material: to be provided online.
Assessment: written exam and report on exercise.

(5) Project part.
In the project part of this module, students will work in teams on a small project. Conditions:
- Each team consists of 4 students and includes both EE and TI students, preferably 50/50%.
- Each team develops its own project idea(s), presents these, and selects one of them on the basis of (a) feedback session(s).
- In each project (proposal), aspects of at least 4 of the 5 tracks should be visible/used.
- Details about the planning of the project, the set-up, etc., will be made available during the module, via blackboard.

All study material will be made available electronically (free of charge).

Content

A cyber-physical system is a system of collaborating computational elements controlling physical entities. A precursor-generation of cyber-physical systems can be found in diverse areas, such as aerospace, automotive, chemical processes, civil infrastructure, energy, healthcare, manufacturing, transportation, entertainment, and consumer appliances. In embedded systems the emphasis tends to be more on the computational elements, and less on an intense link between the computational and physical elements; also, the networking aspects are stressed more in CPS than in "traditional" embedded systems (although the difference between CPS and ES is also partly a matter of taste and terminology).
CPS can be found in electric power grids, transportation systems, integrated car-to-car communication systems, robotics systems, or integrated satellite computing and communicating equipment. CPS must be highly dependable, (energy-) efficient and meet real-time constraints and require customised user interfaces.

This module will provide an introduction cyber-physical systems design, the required specification models and language, and will address a number of application-areas for CPS. Specialised hardware devices, the essentials of real-time operating systems, and essentials of control systems are also presented.

The quarter will consist of two phases. Phase 1 will be a regular lecturing phase, whereas Phase 2 is the project phase, as follows.
In Phase 1 (weeks 1—6 in Q3.2), students will follow courses, tutorials and small labs in the following topics (called "mini-tracks"):
1) formal specification and hybrid systems;
2) sensor and actuator systems;
3A) physical-systems modeling and controller design (for CS), or
3B) embedded control system implementation (for EE);
4) dependable systems and network;
5) real-time operating systems;
6) Joint projects (all students; groups of 4, with mix of EE, TI and possibly other students).

In week 7 there will be written/oral exams/assignments for all the five mini-tracks. During weeks 2—6, we plan a number of (obligatory) "guest lectures" with speakers from the field.
In Phase 2 (last 3 weeks of the quarter), we plan project work (in small teams) in which the material from the Phase 1 will be put to practice in small projects; in Phase 1 a few meetings will be devoted to the project already as well. Result of such a project will be project artefacts (code, models, etc.), a short research paper (max 6 pages, IEEE double column format), one final and two intermediate presentations. Note that the above "put to practice" can mean that students indeed do practical experiments or extended lab work, but might also be of a more theoretical nature. Students will work in teams (up to 5 persons) and come up with their own project idea. Projects can, for instance, be taken from a variety of application fields, such as, car-to-car communications, precision machine control, smart grids, healthcare robotics, data centres, or (satellite) communication systems.
In the last week of the term (week 10) there will be final presentations and "exam repair facilities".

Smart Spaces – Technical Computer Science – Module 9

Learning goals

In this module students will learn the principles, concepts and techniques required to create and evaluate smart spaces. After the module, students are able to:

• explain and characterize principles of smart spaces and underlying methods and technologies
• develop creative, useful, and efficient smart space solutions and services
• explain basics of context awareness, service design and engineering
• explain and design (distributed) algorithms for context awareness, reasoning, and recognition
• design smart interaction methods based on context
• design solutions for and using technologies for user interaction, localization and other areas similarly relevant for smart spaces
• structurally evaluate and analysis of complex interactive smart spaces
• project planning and management
• perform fair self-assessment and reflection based on peer reviewing

Content

Smart spaces refer to environments such as apartments, offices, museums, hospitals, schools, malls, university campuses, and outdoor areas that are enabled for co-operation of smart objects and systems, and for ubiquitous interaction with frequent and sporadic visitors [1].

Prime business scenarios include smart retail environments and public areas providing better service to customers and citizens, and home and office environments making living and working more comfortable and efficient.

The basic principles, concepts, and techniques to be learnt are grouped into four themes, i.e., (i) smart objects and (distributed) sensing, (ii) distributed intelligence and context awareness, (iii) mobile and indoor localization, and (iv) smart interaction. Through lectures and study materials (MOOCs and articles), students will acquire deep understanding and knowledge of the required techniques and principles to create smart spaces. This knowledge will be put into practice during challenges, which in turn will prepare them for the final goal of the module, which is the realization of a smart space during the project weeks.

By focusing on the campus as a living lab, students are requested to generate ideas for creation of a smart space on the campus. The generated ideas will be evaluated in a panel to select the “best idea”.

[1] http://www.eitictlabs.eu/innovation-areas/smart-spaces/

Assumed previous knowledge

Pre-requisite:
• Programing
• Writing reports
• Giving presentation

Knowledge of programming in Java, Phyton or C.

Subjects & Exams

- Smart Spaces
- 2 written exams + 4 challenges + Integration project + Peer-reviews

Soft And Biological Physics – Applied Physics – Module 9

Content

Soft and biological physics is the study of systems where physical interactions occur close to room temperature. A prime example includes liquid electrostatics, whereby charged objects (colloids, DNA, ...) can be manipulated with electric fields (for characterisation, sequencing, ...). So too at the cell level, ion channels within the cell membrane control the flux of ions into and out of the cell. These examples depend on diffusion, migration, hydroph-ob/il-icity, and electrostatic screening, drawing on knowledge from statistical physics, electrodynamics, fluid physics, and solid state physics. As well as providing the theoretical framework to tackle problems in soft and biological physics, this module will also provide you with hands-on experimental experience of a variety of soft matter laboratory techniques.

Subjects & Exams

- Soft & Biological Matter
- Soft and Biological Techniques
- Colloids and interfaces

Science – Advanced Technology – Module 9

Learning goals

After this course the student:

Statistical Physics
1 understands how microscopic partition functions are determined by the atomic composition of a system;
2 can derive partition functions for simple systems;
3 can relate microscopic partition functions to macroscopic thermodynamic potentials;
4 can apply these relations to simple systems;
5 knows the crucial differences between classical (Boltzmann) and quantum mechanical (Fermi-Dirac, Bose-Einstein) systems.
6 can interpret thermodynamic data in terms of microscopic behavior.

Introduction Solid State Physics
1 can identify the structure of a crystal lattice, and its reciprocal lattice
2 is able to calculate a diffraction pattern and invert it back;
3 can describe the concept of phonon dispersion relations and determine the thermal properties of a solid (Debye &Einstein models, thermal expansion);
4 is able to calculate a 1D phonon dispersion relation;
5 can determine the electronic configuration of an atom;
6 can compare the conductivity of a metal with the free electron model;
7 can describe the behaviour of electrons in a periodic potential and explain the concept of a band structure

Molecular structure and spectroscopy
1 is able to understand, explain and apply the physical principles of the Valence-bond theory and the Molecular orbital theory for chemical bonding;
2 understands and is able to apply the hybridization of orbitals;
3 can derive the electronic structure and bond order of homo- and heteronuclear diatomic molecules;
4 can analyze the electronic structure from photoelectron spectroscopy data;
5 can describe general features of molecular spectroscopy
6 discriminates between the underlying photophysical processes of rotational, vibrational and electronic spectroscopy
7 is able to understand, explain and apply the physical principles of rotational, vibrational, electronic spectroscopy

Optics
1 is able to understand and explain basic concepts of geometrical optics (relfection/refraction, Fermat's principle, lens equation).

2 is able to understand and explain basic concepts of physical optics (electromagnetic waves, plane waves, superposition, interference, diffraction)
3 can apply the aforementioned concepts to analyse, design and execute optical experiments

Content

This course gives a further introduction into modern physics and chemistry of (nano)matter. Combining statistical physics and solid state physics, the properties of atoms, molecules and crystalline solids are derived. The module consists of 4 parts: Statistical Physics, Introduction to Solid State Physics, Molecular structure and spectroscopy and Optics.

The content of the four parts is:

Statistical Physics
The focus is on the relation between the atomic composition of a system (atoms in perpetual motion) and the ensuing macroscopic behavior (pressure, temperature, etc). Statistical descriptions are introduced to describe systems of 10^23 atoms in terms of partition functions, and their relations to thermodynamic potentials are discussed. The main topics include statistical definitions of entropy, internal energy and Helmholtz free energy, the Boltzmann distribution, Fermi-Dirac and Bose-Einstein distributions, the fundamental assumption of statistical mechanics, the equipartition theorem, equations of state. These concepts are applied to various simple systems, like ideal and non-ideal gases, solids and liquid mixtures.

Introduction Solid State Physics
A crystalline material is described by its periodic lattice. The associated reciprocal space lattice is introduced and related to the characterization of a crystalline material with X-ray diffraction. The influence of lattice dynamics on macroscopic properties is treated in terms of phonons and dispersion relations. Bose-Einstein distribution is used to evaluate the contribution of lattice dynamics to the heat capacity. The description of electron distribution in a material starts from the free electron model and with the aid of the reciprocal lattice the nearly free electron model is introduced. The concept of effective mass and Fermi-Dirac distribution are explained and several macroscopic features such as electron contribution to heat capacity and conductivity are treated.

Molecular structure and spectroscopy
This part extends the knowledge introduced in the first year quantum mechanics course and discusses the theory behind chemical bonding, as well as spectroscopic characterization. Topics being addressed involve the valence bond theory, hybridization of orbitals, molecular orbital theory, bonding and antibonding orbitals, electronic structures of molecules, introduction spectroscopy, vibrational transitions, rotational transitions and nuclear magnetic resonance.

Optics
In this part we address the basic concepts of both geometrical optics (light as a ray) and physical optics (light as a wave). The course consists of a few lectures and a larger experimental assignment. In the lectures the theoretical concepts will be discussed, while in the experimental assignment the student will apply these concepts to design, construct and characterize an optical instrument (e.g. microscope and/or photo-spectrometer). The instrument is then used to carry out experiments that relate to microscopic/spectroscopic characterization of materials.

Subjects & Exams

- Statistical Physics
- Introduction Solid State physics
- Molecular structure and spectroscopy
- Optics

High-Tech Human Touch Minors

Aeronautical Engineering & Management

Practical information Aeronautical Engineering and Management

- This is a HTHT-minor package
- The package consist of:
- HTHT-minor Aerospace Management & Operations
- HTHT-minor Aircraft Engineering

Description of the advantage by taking both minors

In the module 'Aircraft Engineering', students go much deeper into the technical details of aircraft design. In the module 'Aerospace Management & Operations' many technical aspects are taken as givens. For example: students should know that there is a relationship between wing profile, fuel consumption and required runway length, but they only need to understand this relationship in a global, qualitative way. But in "Aircraft Engineering' they learn the aerodynamic principles behind this relationship (pressure distribution as a function of profile, laminar and turbulent flows etc.) and learn how to make calculations concerning this relationship. On the other hand, 'Aircraft Engineering' does not address the utilization of aircraft and the industrial management processes in the development, use and maintenance of aircraft.

So, students that follow both modules gain knowledge and insight in both the inner workings of aircraft (Aircraft Engineering) and the way aircraft are used to achieve organizational goals (Aerospace Management & Operations). The link is in the relationship between the technical properties of an aircraft and the way these properties determine its user characteristics (its suitability for achieving organizational goals). This link is addressed in Aerospace Management & Operations by addressing the technical properties but taking them largely as givens, and linking them to user characteristics.

Organization:

- Website of the package:
- Repsonsible faculty: Engineering Technology
- Minorteam: Dr. H. Heerkens and Prof. Dr. Ir. André de Boer

Minor 1: Short description of content 'Aerospace Management & Operations'

In this module, you get acquainted with the development and operation of aircraft. The aerospace industry is a fine example of the interrelationships between technology, economics, and the social and human sciences. We explore how the needs of organizations like airlines define the aircraft that aerospace manufacturers like Boeing and Airbus develop, how technology is used to turn aircraft from ideas into reality, and what the role of humans is to operate them safely. We address questions like: which factors determine whether an aircraft is suited for the tasks demanded of it? What are the strategic choices airlines make that determine their success? Why are profit margins of airlines so razor-thin, despite air travel having been a growth market since World War 2? What role does maintenance play in the efficient utilization of aircraft? Why is an inherently dangerous activity like flying one of the safest forms of transport? Why are human factors consistently the main factor holding back safety? Why do governments attach so much value to having an aerospace industry, despite the massive investments that it requires?

We do not confine ourselves merely to theory. Students will experience what it is like to manage their own (virtual) airline. The result is that the disciplines of technology, economics, management and human-machine interface are merged in a natural way and students learn to use an interdisciplinary approach to problems and questions concerning the aerospace industry.

In this module we take the aircraft as the point of focus. We look at its technical and economic properties, its use, its users, the regulations and constraints under which it operates, the ways its performance is assessed. This focus integrates the various technical, economic and social (human) subjects covered in the module.

The civil aerospace industry is the main focus, but military aerospace will also be briefly addressed, if only because civil and military aerospace are so intertwined.

Minor 2: short description of content 'Aircraft Engineering'
Within this module, the student gets acquainted with aspects that play a role in the design of an airplane. The focus is on the history and application of the high tech (mechanics, structures and aerodynamics) as well as the human touch aspects (decision making, business case).

The central theme in the module is the conceptual design of an aircraft. In this design all knowledge gained during the courses Aircraft Technology, Aircraft Structures and Aerodynamics is applied and integrated. The conceptual design will be done in groups of about 5 students. The design must be presented and defended for all other module students and the team of lecturers being the board of the company that delivered the assignment and (demanding) requirements for the design.

The module starts with a brief account of the history of aviation, the evolution of aircraft configurations, the principles of flight. Subsequently the aerodynamics of aircraft wings (lift, drag, pitching moment, stall, critical Mach number, drag-divergence Mach number) is explained, with some emphasis on transonic transport aircraft. Further attention is paid to the most important structural parts of an aircraft. Their designation and their function in the structure are presented. Special attention will be paid to the new composite materials that are more and more used in aircraft industry.

Personal Experience - Robin Elbersen – Aircraft Engineering

Hoe is de minor bevallen?
Aircraft Engineering is een uitdagende minor waarin je veel nieuwe dingen leert. Hieronder heb ik de verschillende vakken even uitgesplitst:

Aircraft structures:
In Aircraft structures komt de mechanica van vliegtuigen aan bod. In dit vak zul je je voornamelijk bezig houden met het berekenen van krachten in bijvoorbeeld de vleugels, staart en romp van een vliegtuig. Andere dingen die in dit vak aan bod komen zijn bijvoorbeeld materiaalkeuze van een vliegtuig. Wiskundig is het vak niet al te moeilijk en vergelijkbaar met de wiskunde die je ook bij ST vakken hebt. Mechanica heb je op ST niet gehad en dit zal dus besproken worden in de eerste paar lectures. Hierdoor kan het vak in het begin best druk worden, aangezien de theorie volledig nieuw is voor een ST'er.

Introduction to aircraft technology:
In het vak IAT houd je je voornamelijk bezig met iets meer algemene dingen over vliegtuigen. Bij dit vak wordt bijvoorbeeld besproken waarom een vliegtuig op een bepaalde hoogte vliegt, hoe ver een vliegtuig kan vliegen en natuurlijk ook waarom een vliegtuig eigenlijk kan vliegen. Bij dit vak zal ook een stukje aerodynamica aan bod komen. Bij het vak aerodynamica ga je hier dieper op in. Qua wiskunde is dit vak wederom te vergelijken met ST vakken.

Aerodynamics:
Aerodynamics is wiskundig gezien het moeilijkst. Bij aerodynamics houd je je voornamelijk bezig met "lift", oftewel de opwaartse kracht op een vleugel. Voor het vak aerodynamica is het belangrijk dat je wiskunde goed begrijpt. Met name math D2 (vectorcalculus) komt hier veel aan bod. Hierbij is het belangrijk dat je niet alleen de formules die je bij wiskunde hebt geleerd toe kan passen, maar het is ook belangrijk dat je de achterliggende wiskunde goed begrijpt. Aerodynamica was het vak wat ik persoonlijk het lastigst vond.

Project concept design of an aircraft:
In het project ga je zelf met een groepje een vliegtuig ontwerpen. Het project is erg uitdagend en ik heb er persoonlijk veel van geleerd. Het leuke aan het project is dat je met veel verschillende disciplines samenwerkt. Zo bestond mijn groepje uit werktuigbouwkundigen, technisch natuurkundigen en ook industrieel ontwerpers. Door deze samenwerking leer je veel verschillende dingen die in andere disciplines aan bod komen. Voor het project staat volgens mij rond de 2,5 EC, maar ga er maar van uit dat je qua tijd rond de 5EC moet zitten. Het is een project waarin planning zeer belangrijk is, aangezien het ontwerp van een vliegtuig gewoon veel tijd kost.

Hoe was de tijdsbesteding en moeilijkheid?
Aircraft engineering is een minor waar veel tijd in gaat zitten. De tijdsbesteding is vergelijkbaar met een drukke ST module. De hoeveelheid tijd die in de minor gaat zitten wordt ook grotendeels bepaald door de bijna wekelijkse assignments die je in moet leveren voor elk van de genoemde vakken. Deze assignments zijn ook nog eens best uitdagend. De moeilijkheid van de minor hangt voornamelijk af van hoe goed je in wiskunde bent. Als je wiskunde goed begrijpt (met name vectorcalculus) dan is de minor goed te doen. Mocht je wiskundig niet zo sterk zijn dan raad ik je niet aan om deze minor te kiezen.

-Hoe was de aansluiting op ST? Had je genoeg voorkennis en kun je de kennis die je tijdens de minor hebt vergaard gebruiken bij ST?
De aansluiting op ST is redelijk. Vakken zoals aircraft structures zijn voor ST'ers volledig nieuw, aangezien je op ST weinig mechanica krijgt. Andere vakken, zoals aerodynamica sluiten wel redelijk aan aangezien er een stukje stromingsleer in voorkomt wat je bij ST ook gehad hebt. Qua voorkennis is het dus belangrijk dat je wiskunde goed begrijpt en dat je affiniteit hebt met wiskunde. Dan zijn de vakken zoals aircraft structures en aerodynamica goed te doen.

Ik hoop hiermee voldoende uitleg gegeven te hebben over Aircraft Engineering.

Groeten,
Robin

Personal Experience – Jorn Heinst – Aircraft Engineering

De minor Aircraft Engineering bestaat eigenlijk uit 4 onderdelen: de vakken Aircraft Structures, Aerodynamics en Aircraft Technology en het project Concept Design of Aircraft. Voor elk vak zul je gedurende de module vier (redelijk grote) assignments in moeten leveren, en van elk vak zul je aan het eind van de minor een tentamen krijgen, als je deze niet haalt krijg je een herkansing, dit is een mondeling.

Aircraft Structures gaat vooral over de meer werktuigbouwkundige aspecten van een vliegtuig, je zal bijvoorbeeld dingen leren over welke onderdelen gebruikt worden, waarvoor ze gebruikt worden en waar in het vliegtuig ze te vinden zijn, ook worden bij dit vak de mechanische aspecten behandeld, bijvoorbeeld wat flutter is en hoe dit voorkomen kan worden. Dit vak vond ik zelf goed te doen, het is voor ons als ST-studenten wel allemaal nieuw, maar als je het vak goed bijhoudt dan komt het zeker goed.

Aerodynamics gaat, zoals de naam al doet vermoeden, over de aerodynamica van een vliegtuig, en dan met name over de luchtstroom om de vleugels heen, en hoe deze de krachten produceert die het vliegtuig in de lucht houden. Dit vak vond ik het moeilijkst, het is heel wiskundig en abstract en lijkt helemaal niet op de stromingsleer die wij al in module 6 gehad hebben. Ik vond het daarentegen wel interessant en heb het gehaald door er veel tijd in te steken, dit is ook echt nodig om het vak te halen. De assignments voor dit vak die je door de module heen moet maken zijn allemaal heel wiskundig, maar gelukkig hoef je op het tentamen aan het eind van de module alleen uit te kunnen leggen hoe alles werkt, en zul je zelf die wiskunde niet meer toe hoeven passen.
Aircraft Technology behandelt wat er bij de overige twee vakken niet behandeld wordt en is wat algemener, je zult hier bijvoorbeeld leren hoe een vliegtuig in evenwicht blijft en hoe je uit kunt rekenen hoe veel ruimte er nodig is om op te stijgen of te landen, je zult hier ook wat aerodynamica toe moeten passen en je leert ook wat over de aandrijving van vliegtuigen, dus over de motoren en propellers. Dit vak vond ik het makkelijkst, er zijn een aantal concepten die je goed moet begrijpen maar deze stellen niet al te veel voor.

Het project Concept Design of Aircraft is een groepsopdracht waarin je met zes mensen aan de slag gaat om een vliegtuig te ontwerpen dat aan een aantal eisen moet voldoen. Bij dit project zul je alle kennis die je hebt verkregen bij de verschillende vakken van de module toe moeten passen, ook zul je een afweging moeten maken welke eisen belangrijker zijn en welke minder belangrijk, aangezien het voldoen aan de ene eis als gevolg kan hebben dat de andere eis niet meer haalbaar is. In het begin van de module werd gezegd dat het echt belangrijk was om meteen met het project te beginnnen omdat het anders veel te veel was, wij hebben ons natuurlijk van dit advies niks aangetrokken, maar dit heeft tot gevolg gehad dat ons project onvoldoende was en dat we deze in module 11 hebben moeten verbeteren, het is dus echt belangrijk om optijd te beginnen. Ik vond het project persoonlijk verschrikkelijk, je wordt ingedeeld bij willekeurige mensen die, zeker aangezien er veel TN'ers en TW'ers deze minor doen, meerdere klappen van de molen hebben gehad. Ook was het project gewoon te veel werk en werden er voor mijn gevoel veel te hoge eisen aan ons werk gesteld, ik heb er denk ik dubbel zo veel tijd in moeten stoppen als in het project van module 6, wat voor mijn gevoel wel een aardig grote opdracht was.

Ik twijfel een beetje of ik deze minor aan kan raden, aan de ene kant heb ik veel dingen geleerd die ik interessant vond, maar aan de andere kant ben je er gewoon heel veel tijd aan kwijt, en zul je de kennis die je geleerd hebt waarschijnlijk nooit meer gaan gebruiken. Ik kan je de minor dus alleen aanraden als het onderwerp je echt interessant lijkt en als je bereid bent er veel tijd in te steken, zelf heb ik er een beetje spijt van gehad dat ik deze minor gekozen heb, dus als je denkt dat je enigszins hetzelfde in elkaar zit als ik dan zou ik een andere minor kiezen waar je minder tijd aan kwijt bent, zodat je af en toe nog eens het licht uit je ogen kan zuipen.

Groeten,
Jorn Heinst

Personal Experience - Thomas Remmerts - Aircraft Engineering

Module 10 (second quartile)

Motivation

The reason why I chose this minor is because I heard it was a rather challenging module that combines some aspects that are related to Chemical Engineering, like fluid dynamics from module 6 and structural stress calculations from module 3. Also as I had a board year and a rather non-technical minor before it, I thought it was a good idea to follow this to get back into something more related to Chemical Engineering. Also, a lot of people that really liked planes or Mechanical Engineering, chose to follow this module.

Aerodynamics

This topic is mainly focused on learning you how a wing of an aircraft generates lift, so the plane can actually fly. The calculations on the airfoils are based on fluid dynamics similar to module 6, but contain way more vector calculus and some differential equations, which took me some time to refresh. Especially the first few lectures were really up-tempo and it was kind of difficult to grasp all at once. However, every two weeks an set of assignments had to be handed in by couples of two, which really helped me in not slacking and falling behind. Although the first few weeks were kind of stressful for me, the last few weeks everything really fell into place. After all I can say I really learned a lot from this subject and got a better understanding about fluid dynamics as a whole.

Aircraft Structures

In this part of the module we focused a lot more on the strength of different materials under different circumstances. Again some vector calculus came into practice here, which took me some time to get used to. There are multiple lecturers, who have their own specific topic within structure analysis for aircraft and most of them do a pretty good job in visualizing how materials act under certain stresses and explaining why this happens. Also for this topic, there were assignments that had to be handed in every two weeks together with a partner. This subject really helped me in understanding how stresses influence design choices and how the properties of materials can be used efficiently. When you plan on following Process Equipment Design (PED) in module 11, this knowledge is definitely very useful.

Introduction to aircraft technology

This is probably the topic that is most related to the aircraft itself and it really gives an engineering approach to how planes are designed. The lecturer is sometimes a bit hard to follow during lectures, but is very good in explaining things when you ask him in person. However, the engineering approach means that a lot of calculations are rules of thumb and I felt that I could finish the subject rather easily with some self-study. Also here there were assignments to be handed in every two weeks, which were closely linked to the project and helped in calculations for the project.

Project 'Concept design of an aircraft'

The project felt like it was a very nice integration of the three theoretical subjects. The groups were divided in a way that you work with students from a lot of other disciplines. As everybody has a kind expertise in some part of the project it was a nice way for everybody to use its strengths and at the same time learn a lot from others. For the project the only thing you get is a bunch of requirements and it is your task to design a plane that meets (almost) all of these. As there was so little guidance it was rather difficult to get a clear what was important for the project en what was not. This meant that a lot of the time was spent on discussing and finding out how the three subjects influence each other. However, it was really interesting to build a project completely from scratch.

Time intensity and comparison with Chemical Engineering

The time I had to invest in this module was comparable with an average or somewhat above average module of Chemical Engineering. Especially when you struggle with some parts of calculus or fluid dynamics like me, this is definitely not an easy module. However it might save you some time in later modules as you do get a better understanding in some related subjects.

From the knowledge you obtained in your previous modules, I certainly think this module connects very well to Chemical Engineering. However, as most of the students are Mechanical Engineers, it might be a good idea to refresh your vector calculus and fluid dynamics.

Overall, I think I really learned a lot from this module that is also relevant to my future study. Although it was really stressful and difficult for me at some points, (I also invested about 10 hours per week in activism) I would definitely recommend following this module if you really want to learn something.

Greetings,

Thomas Remmerts

Geographic Informatin System and Earth Observation

Practical information Geographic Information System and Earth Observation

- This is a HTHT-minor package
- The package consist of:
- HTHT-minor Geographic Information System (GIS)
- HTHT-mino Earth Observation (EO)

Description of the advantage by taking both minors
Students who take both minors get the complete picture of acquiring, storing, analysing and visualizing geo-information. They can directly make the relation between how one can sense processes on earth and how that can be translated to information on a global, national or even individual level.

Essential difference between the minor GIS and the minor EO is that GIS is focusing on the storage, use and visualization of geo-information, whereas EO is focusing on how to acquire geo-information at various scales and for different purposes. In projects in the GIS minor students how to use existing data for a particular application. In EO the focus is on how to acquire and process data in order to fill the needs for local, regional or global issues.

Organization:

- Website of the package:
- Repsonsible faculty: Geo-Information Science and Earth Observation (ITC)
- Minorteam: Prof. dr. ir. A. Stein and Dr. ir. S.J. Oude Elberink

Minor 1: Short description of content 'Geographic Information System'
A Geographical Information System (GIS) is a collection of methods and tools associated with answering geographical questions. GIS is a generic term for the use of computers to study and visualize geographical patterns and processes (natural and manmade) that occur on the surface of the Earth. There are many uses for GIS in different scientific and operational domains. Common application areas are urban planning, public administration, environmental monitoring, utilities, telecommunications, transport, hazard analysis, topographic mapping, and the management of agriculture, forest and water resources. In the past few decades, GIS has developed into a major area of application and research and into an important global business. Today, GIS is an active and rapidly expanding field, which generates considerable public and private interest.

The leading theme of this module is: *how can GIS be used efficiently for global and actual problems*. It consist of three stages: the first efficiently supplies basic knowledge to the corresponding theme (4 EC), the second applies the knowledge in relevant domains (5 EC), and the third integrates the acquired knowledge in a project framework (6 EC).

Students will get lectures in combination with (un)supervised exercises. Lectures and exercises are designed such that the basics of storing, accessing and analysing geo information are covered. Students are encouraged to find creative solutions in the use, design and analysis of GIS functionalities. Treated are the concepts of multi-scale and geometric aspects of mapping in a GIS context, dissemination methods and environments, with emphasis on online and interactive methods.

The final part of this module consist of an inter- or multi-disciplinary project. Projects with an international flavour related to the various societal benefit areas (SBA's) are proposed from which the students can choose. Focus is on how GIS can be used effectively by combining (geo-) information to provide possible solutions/plans and to allow an efficient communication with stakeholders

Minor 2: Short description of content 'Earth Observation'
The minor on Earth Observation deals with sensors, platforms and data processing techniques that are used to derive information about physical, chemical and biological properties of the Earth's surface without direct physical contact. Sensors can be mounted on Earth orbiting satellites, aircrafts, but can also be mounted on a car or even hand-held. Sensors measure electro-energetic emissions from objects and material on the earth's surface. Data processing techniques subsequently transform raw data into meaningful information sources for a large variety of applications.

The leading theme of this module is: *how are Earth Observation Data collected and how can they be optimally used*. This module consist of three stages: the first efficiently supplies basic knowledge to the corresponding theme (4 EC), the second applies the knowledge in relevant domains (5 EC), and the third integrates the acquired knowledge in a project framework (6 EC).

The first phase handles the basics on Earth observation (EO) techniques, and gives an overview of several sensors capable of capturing characteristics of the earth. In the second phase of quartile 10 Earth Observation is used to let the student learn how raw data are processed into meaningful information by analysing and designing various applications, such as disaster mapping and monitoring, 3D city and landscape modelling and urbanization. In this phase students learn how to combine data, use multi-resolution data, assess aspects of spatial resolution, spectral information and thus make the most out of the available satellite information. We design an interesting schedule of lectures and exercises, starting from small scale in week 3, medium scale in week 4 and large scale applications in week 5. The final part of this module consist of an inter- or multi-disciplinary project. Students can choose from at least two options.

Innovation, Entrepreneurship & Business Development

Practical information Innovation, Entrepreneurship & Business Development

- This is a HTHT-minor package
- The package consists of:
- HTHT-minor Innovation & Entrepreneurship
- HTHT-minor New Technology Business Development

Description of the advantage by taking both minors
The relation between modules 9 and 10 of this package is that the first prepares for independent venturing, based on commercialization of a product/service idea into a plan that assesses feasibility of the idea. The second takes this knowledge into an inquiry that aims at exploiting an invention by identifying conditions and potential adopters and users of the technology for the decision either or not to appropriate it by the UT for future technology transfer purposes. The commonality is inquiry into opportunities for business development as independent venturing in module 9 and for technology transfer purposes in module 10.

The second module is not only directed towards creating a new company (independent venturing), but also to business development from a research technology organisation (such as universities and public as well as private institutes) or from a medium-sized to large company. The modules together prepare for a larger application area of knowledge and skills to be taken from this undergraduate education program.

Organization:

- Website of the package:
- Repsonsible faculty: Behavioural, Management and Social Sciences (BMS)
- Minorteam: Joost Brinkman (j.g.brinkman@utwente.nl)

Minor 1: Short description of content 'Innovation & Entrepreneurship'
This module starts with an introductory **Acceleration Program** that sensitizes students to the dynamics of the entrepreneurial business model development for 4 days. This is a quick way of making students aware of the knowledge they lack and need to master for operating in and communicating about business. It also introduces in developing a technology-based start-up into a successful company. In a playful manner, participants interact in multidisciplinary teams in the Acceleration program, the project as well as case work during the module. The **business planning project** synthesizes knowledge to be gained from the courses described below and will be based on a product and/or service concept developed in (a) prior module(s) by someone within the venture team. A lot of fieldwork is involved using the lean start-up approach, continually testing assumptions, claims and data retrieved from secondary sources in desk research to minimize market risk and improve the concept for real-life adoption to prove a business case.

For the necessary analysis and business design work to be done, students need additional knowledge that is offered in three introductory courses on entrepreneurship, innovation and financial management.

In these courses, a decision-centred approach is taken in case teaching where - again - students work on real-life problem situations companies have dealt with in order to prepare for a properly analysed and argued decision to be made for the case proponent.

Introduction to Entrepreneurship is about different forms and categories of entrepreneurship, the differences and commonalities between the entrepreneurial and the innovation process, as well as the jargon and conceptual basics of business disciplines like strategy, finance, marketing, and personnel and organisation.

The subject of innovation management introduces students to different forms and categories of innovation as process and as result. As a discipline, it is largely based on corporate as well as policy practice, and translated to technology-based start-up theory in order to help students understand the typical differences between large and small organizations in their strategies and resource management for commercializing new product and service ideas.

Finally, to avoid the Valley of Death pitfall, students are introduced to the basic instruments of financial management of innovative enterprises. Focus is on understanding and composing a balance sheet, income statement and cash flow statement as part of acquiring and managing resources to invest in and develop the technologies required to realize and market their product/service idea.

Minor 2: Short description of 'New Technology Business Development'
Over the last two decades the amount of business that has been generated on IPRs has increased dramatically, making them the fourth production factor in economies today. All technology-oriented curricula should transfer knowledge that explains for the proportionate increase of immaterial asset value in our corporate finance practices. The commercial effect of such corporate immaterialization is that markets for technology have grown to such an extent that they will become institutionalized in the near future and not only will large companies use them, but also technology research organizations an inventive SMEs as suppliers of new proprietary technologies.

This minor is the more advanced part of the minor that builds on the minor Innovation & Entrepreneurship in adding the subjects of intellectual property management (IPM) and marketing in a high-tech context (HTM). Specific for this more advanced marketing topic is the role of e.g. the new product development process and of patent licensing as a way of exploiting inventions and thereby gaining revenues without having to invest heavily in product development and manufacturing capabilities. The two course subjects are complemented with a business research project in which student teams study ways in which a UT invented technology can be exploited in order to support the decision whether or not to appropriate the idea and consequently make expenses for patenting as a university, or suggesting other ways of diffusing the idea to the innovators.

The subject of IPM focusses on patents for the role of technology in our university and therefore this innovative entrepreneurship package. The other intellectual property rights (IPRs; trademarks and copy right) will be dealt with shortly in both IPM and HTM. IPM deals with not only legal, but also organizational, informational, commercial and financial aspects of patents and patenting in order to build a coherent strategy on generating not only costs but also revenues on them.

HTM deals with such topics as the role of technology standards, new technology acceptance and adoption, innovation in networks, and the new product development process as part of the open innovation context in which such issues need to be dealt with.

Both these subjects are conventionally organised into courses that stage wise provide students with theoretical concepts and analytical models to apply in data gathering and use for interpretation purposes in the project work.

Philosophy and Governance of Science and Technology

Practical information Philosophy and Governance of Science and Technology

- This is a HTHT-minor package
- The package consist of:
- HTHT-minor Philosophy of Science and Technology
- HTHT-minor Governance of Innovation and Socio-Technical Change

Description of the advantage by taking both minors

In this package consisting of two HTHT modules students will develop a basic understanding of how science and technology influence the human being and society, focusing on human behaviour, knowledge and values, and on evaluating and governing social change. They will do so using insights and perspectives from philosophy (this module), from science and technologies studies and governance studies (the 'Governance of Innovation and Socio-Technical Change' module), and by applying those to projects in which students will work on concrete examples of technologies in collaboration with the UT science and technology institutes (both modules).

Organization:

- Website of the package:
- Repsonsible faculty: Behavioural, Management and Social Sciences (BMS)
- Minorteam: Dr. Marianne Boenink and Dr. K. Konrad

Short description of content Philosophy of Science and Technology

This minor analyses and evaluates the influence of science and technology on humans and society. Students will be introduced in the main approaches and theories in the history of philosophy, which will enable them to reflect more systematically and critically on science and technology and their social roles. But rather than merely studying the philosophical tradition in itself, or aiming to understand technology in general, the focus will be on acquiring skills in order to philosophically analyse specific technologies and technological practices. How will, for example, wearable technologies like Google Glass and Hololens change and shape our social interactions? How will we be able to maintain traditional ideas about privacy in an age of exponential increase of information and communication technologies? And how will our society and culture incorporate and shape those technologies? Since these reciprocal influences are value-laden, the minor will investigate normative aspects of technologies: how have specific technologies affected our ethical and political views? The focus on practices will also shed a new light on the role of science: scientific knowledge will be approached as a tool for technological design. In a so-called Philosophy of Technology Lab students will work in teams on specific technologies on the basis of acquired perspectives and insights from philosophy.

The minor consists of 3 thematic components and a project. In the component 'Philosophical Theories and Methods' students are introduced to various approaches and methods within philosophy and lays a basis for the other components. The component 'Cyborgs, Hybrids and Posthumans' focuses on how technology influences and constitutes human nature and human existence and how emerging technologies seem to blur the boundaries between humans and machines. The component 'Technology, Ethics and Society' focuses on contemporary social and ethical problems and the role of technology in these problems. The component 'Knowledge as epistemic tool' aims at a better understanding of the role of scientific research in technological applications. In the Project 'Philosophy of Technology Lab' students analyse technologies developed by researchers at the University of Twente on the basis of insights they gain in philosophy of science, human-technology relations, and ethics. They will also investigate the impact of technologies on certain philosophical assumptions.

Short description of content 'Governance of Innovation and Socio-Technical Change'
In this module you will learn how society and technology influence each other, in particular how this plays out in innovation processes when new technologies are developed and embedded into society, and what are possibilities for purposefully shaping innovation processes.

We constantly witness how innovations affect various areas of society and social life, but identifying and working towards innovations which actually fulfil society's needs and to embed them successfully into real world contexts is not an easy task. Given the central role that many technologies have for modern societies, be it in the form of enablers of key societal functions as energy, transport, public health etc., or as creating risks and unwanted effects, science and technology are also an important issue for governance, with policy and other societal actors trying to shape innovation and societal embedding. As part of this, prospecting possible technology dynamics and also their effects on society is a common activity for research, innovation and governance actors, but needs to be informed by a proper understanding of socio-technical dynamics.

Following this module will allow (technical) students to reflect and anticipate on the societal relevance of particular technologies and on the way the world 'beyond the lab' influences the work of researchers and designers. Students (from the social sciences) will enhance their understanding of technology and innovation as essential ingredients of modern social life, and the role policy and social science can play in the governance of science and technology in society.

The module consists of 3 thematic components and a project. The first component is dedicated to developing an *understanding* of the interrelations of innovation and social change and how these typically unfold. This includes the 'journey' a new technology may take from development to becoming embedded in user's practices and getting to work in broader socio-technical environments, and the roles of different actor groups therein. For instance, new telecare or point-of-care devices have to find a place in patient's daily life or medical routines, just as in the broader health system. Electric vehicles interact with user's mobility patterns, and have to be integrated into the mobility and (smart) electricity system more widely. E-government may facilitate information flows, but also change roles and power relations of various actors. New sensors for measuring water quality have to fit with the way how quality monitoring is organized in water companies and fulfil regulatory requirements. Along such an 'innovation journey' more or less unexpected changes in user's practices, broader systems and the innovations themselves may be the result. Both contemporary and historical examples will be used to explore this empirically.

The second component addresses how these insights can be used for *anticipating* on and partly assessing future developments of and around innovations, for instance in the form of scenarios, and how this can feed into innovation processes. Furthermore, you will learn about the (often) strategic role of expectations and promises in research and innovation, and their dynamics – e.g. hype-disappointment cycles, and what this means for innovation actors.

The third component delves into possibilities, approaches and limitations of *governing*innovation and socio-technical change, building on the insights of the former two components. Finally, we will inquire about the role of science, technology and scientific expertise in policy-making and governance more broadly.

In the project, groups of students work on a case of a particular technology or application, and apply insights from the thematic components, resulting in e.g. a strategy recommendation for an innovation actor, a policy recommendation, or a scenario development.

Science to Society

Practical information Science to Society

- This is a HTHT-minor package
- The package consist of:
- HTHT-minor part 1: Science to Society: From Idea to Prototype.
- HTHT-minor part 2: Science to Society: From Prototype to Society.

Description of the advantage by taking both minors

This consecutive design minor focuses on real-world problem solving in multidisciplinary teams, around the societal challenges in divers fields like energy, health, learning and robotics. Creative design ideas and technological innovations in cooperation with different societal stakeholders are needed to tackle these challenges. In the first module, you will work on generating innovative ideas and design concepts, and transforming the initial concept into a prototype. Taking both modules means you will see the realization of your concept and will thoroughly deepen your understanding of the topic field and the state-of-the-art in technological innovation.

Organization:

- Website of the package: Science2Society
- Repsonsible faculty: Engineering Technology (CTW) - Industrial Design
- Minorteamcoordinator: dr. ir. R.G.J. Damgrave (Roy)
- r.g.j.damgrave@utwente.nl

Minor 1: short description of content 'Science to Society: From Idea to Prototype'

In this module in a small team of students from different backgrounds, you will research a selected problem and design a solution, integrating perspectives from the frontiers of science with the constraints of technology, business, government, and society. Private and public partners bring in the project cases, derived from on-going research. Solutions can range from, e.g. the design of a distributed system, persuasive technology for monitoring or coaching, or a serious gaming design. To structure iterative research and design process, you will learn and apply a project management methodology.

In the first part of this module, you will choose a project case (problem) and work on setting up the group project. Introductions to design thinking and project management are provided. You will be also introduced to the foundations of different scientific disciplines through guided peer-learning. You will will be able to choose and follow a number of short mini-courses to deepen the understanding and research skills in the field of the chosen project case, as well as develop the skill set necessary to design solutions.

Module 2: Short description of content 'Science to Society: From Prototype to Society'

In this module you and your fellow students form different background will focus on realizing a concept by making use of a prototype made in the first module by maybe other students. In the process the prototype will be enriched with a business model addressing its feasibility.

Personal Experience – Ruben Uineken – Science to Society

In de eerste 2 modules van dit collegejaar (2017-2018) heb ik de High Tech – Human Touch minor Science to society gevolgd, bestaande uit de *Idea to prototype* (module 9) en *Prototype to society* (module 10). Deze modules sluiten volledig op elkaar aan, maar het is ook mogelijk om slechts 1 module te volgen, al zou ik adviseren om wel beiden modules te volgen.

Tijdens deze eerste module ben je vooral bezig met het uitwerken van verschillende ideeën op basis van de case die je hebt gekozen, iets waar je je tijdens ST eigenlijk niet mee bezig houd. Je leert te werken met de design-cycle, je wordt bekend met iterative design en je gaat veel schetsen en concepten uitwerken. Om te zorgen dat ook niet IO studenten hierover kennis krijgen zijn er een aantal ondersteunende workshops en colleges. Uiteindelijk hou je enkele ideeën over die je gaat door ontwikkelen tot prototypes, om uiteindelijk aan het einde van de eerste module een werkend prototype te hebben gemaakt.

Vervolgens ga je tijdens de 2e module verder met dit prototype en de ideeën om ze verder door te ontwikkelen tot een echt product. Ook ga je bijvoorbeeld de mogelijke impact van je product bekijken en schrijf je een 'business plan' over hoe je je product op de markt zou kunnen brengen. Dit product was onze 'Moject sleeve', een tool die docenten ondersteund in het beoordelen van de technische operatie vaardigheden van masterstudenten Technische Geneeskude

Dat is in het kort hoe de minor in elkaar zit. Wat ik vooral leuk vond aan 'Science to Society' was de vrijheid die je kreeg om je eigen ding te doen. Eigenlijk staat er heel weinig vast en wordt je best wel in het diepe gegooid. Het is aan jou en je groepje om contact te houden met de caseleverancier en er achter te komen wat zij precies van je verwachten. Deze vrijheid zorgde erbij ons voor dat we ons helemaal op het project konden storten.

Uiteindelijk heb ik hier samen met mijn groepje een product gemaakt waar onze begeleiders zeer tevreden mee waren, maar wat ook echt nuttig en relevant is. Onze 'Moject sleeve' wordt nu gebruikt in vervolgonderzoek naar de invloed van bewegingen bij specifieke medische ingrijpen, we hebben dit product mogen presenteren op een heus medisch congres en, als alles goed loopt, zal ons product volgend jaar echt gebruikt worden bij de beoordeling van studenten. Dit is natuurlijk veel epischer dan de 1000e student zijn die een bekend stappenplan volgt om iets te maken, wij hebben echt iets unieks neer gezet.

Dat wil niet zeggen dat de minor niet zijn problemen heeft. Zo is de organisatie niet altijd even goed en moet je vaak achter de module coördinatoren aan om wat geregeld te krijgen. Het loopt allemaal wat minder soepel en vanzelfsprekend dan je misschien bij ST gewend bent, maar dat vond ik ergens ook wel weer mooi. Het beloond namelijk groepen die initiatief durven te nemen en vooruit denken en plannen.

Qua tijdsbesteding verplicht deze module niet veel. Je hebt geen vakken, alleen maar een aantal ondersteunende workshops. Dit zorgt ervoor dat je heel veel je eigen tijd moet inplannen. Effectief heb ik een vergelijkbare hoeveelheid tijd of zelfs iets meer aan deze module besteed dan een gemiddelde module bij ST. Dit is echter afhankelijk hoeveel tijd je er in wil steken.

De minor 'Science to Society' is iets voor jou als je bereid bent hard te werken aan een bijzonder, eigen project in teamverband met veel verschillende mensen met verschillende achtergronden. Het vereist meer discipline en planning dan een normale ST module, maar als je daartoe bereid bent kan je echt iets bijzonders neerzetten en veel leren over productontwikkeling.

Met vriendelijke groet,

Ruben Uineken

Innovations in Sustainable Chain Management

Practical information Innovations in Sustainable Chain Management

- This is a HTHT-minor package
- The package consists of:
- HTHT-minor Innovations in Sustainable Chain Management; Analysis
- HTHT-minor Innovations in Sustainable Chain Management; Design

Organization:

- Responsible faculty: TNW
- Minorteam: Dr. F.H.J.M. Coenen and K.R.D. Lulofs

Description of the minor package

The central theme of this Minor is the sustainability analysis and management of integral chains of resources, materials and societal processes. These type of chains are known under phrases like 'from land to table', 'from cradle to grave' or 'from sand to chip'.

Approaches to sustainable integral chain analysis and management have different labels like sustainable supply management, sustainable value chain management, circular economy, etc. All these approaches share the same holistic approach to the sustainability of processes in society. Mapping material streams (input-output and metabolism) is needed, but does not provide a sufficient approach towards sustainability in these chains. It needs a multi-disciplinary analyses of these chains and for solutions from different (multiple-) disciplines to optimize the sustainability of these chains. The need for knowledge on energy and resource efficiency, on process emissions, logistics, law and governance, chain (network) management , transition management, etc. to analyze and manage such chains from a sustainability perspective makes this theme very suitable for a High Tech Human Touch module.

In both modules we will work with a real life case from a societal goal perspective and with local and regional stakeholders. For instance how can a region use more locally grown food and make the regional food production chains more sustainable? How can a region reduce the amount of waste in its regional production chains and reduce the emissions in the chain? Both the analysis and the design of solutions take a social, technological and integral perspective.

In the first module *Analysis* you learn to map and analyze the interaction between materials, technology, economy and society in chains from different disciplinary perspectives. In the second module *Design* you practice how to design sustainable solutions for the problems found in the analysis. In both module you will expand knowledge in your own discipline, learn the basics from other disciplines and work in multidisciplinary teams in the analysis and the design in the real life case.

Leren Lesgeven

In deze minor maak je kennis met lesgeven in het voortgezet onderwijs. Je gaat aan het werk met een van de schoolvakken informatica, maatschappijleer, natuurkunde, scheikunde, wiskunde, of economie/M&O. Kennis en vaardigheden die je voor het lesgeven nodig hebt, verwerf je door interactieve werkcolleges, discussies, simulaties, maar ook en vooral door de stage op school. Je begint met kleine stapjes – oefenen met je medestudenten – en eindigt met zelfstand

Voor wie is de minor geschikt?

De basismodule van 15 EC is geschikt voor alle wo-bachelorstudenten. De complete 30 EC minor (basismodule + vervolgmodule) staat open voor wo-bachelors die daarmee onderbouw docent kunnen worden. Om welke schoolvakken en welke bacheloropleidingen het gaat, vind je in het overzicht van mogelijkheden op de UT-minor website. Als onderdeel van de intakeprocedure vragen we je na de inschrijving om een korte motivatiebrief te schrijven. De lerarenopleider geeft je aan het eind van de eerste module een geschiktheidsadvies.

Waarom is de minor Leren Lesgeven interessant?

Je maakt kennis met lesgeven. Dat omvat natuurlijk veel meer dan alleen lesstof presenteren. Je leert hoe je jouw kennis toegankelijk kunt maken voor leerlingen (of andere groepen). Begrijpen ze het wel? Zo niet, hoe pak je het dan aan? Hoe speel je in op bepaalde situaties die zich voordoen in jouw klas of groep? Via een workshop theatervaardigheden en verzorgen van minilessen leer je met je medestudenten meer over hoe je je zelf presenteert en hoe je overkomt op je doelgroep. Op school oefen je onder begeleiding van je stagedocent en reflecteer je op je ontwikkeling als docent. De ervaring die je opdoet tijdens deze minor, blijf je tijdens je hele carrière toepassen!

Opbouw van de minor

De basismodule omvat drie vakken van elk 5 EC: Onderwij skunde, Inleiding vakdidactiek en Schoolpracticum 1 (stage). Wil je met de 30 EC minor een onderbouw lesbevoegdheid halen? Dan heb je in de vervolgmodule nog drie vakken, namelijk: Vakdidactiek 1 (5 EC), Didactiek onderbouw (3 EC) en de Onderbouwstage (7 EC).

- Onderwijskunde minor (5 EC)
  Dit vak richt zich met name op de interpersoonlijke en pedagogische competenties van de docent. Daarnaast is er aandacht voor leren en instructie, het ontwerpen van onderwijs en reflectie.
- Inleiding Vakdidactiek (5 EC)
  Je houdt je in dit vak onder meer bezig met de doelstellingen van het onderwijs in een schoolvak, de voorbereiding van de lessen, activerende didactiek, probleemoplossen en leerlingstrategieën. Het ontwikkelen van een theoretisch kader en verankering van de schoolpracticumervaringen zijn ook belangrij ke aandachtspunten. Verder omvat dit vak het onderdeel “Presentatievaardigheden”.
- Schoolpracticum 1 (5 EC)
  Je leert de school kennen, observeert lessen en geeft zelf een serie van ongeveer 20 lessen over vakspecifieke onderwerpen.
- Vakdidactiek 1 (5 EC)
  Dit vak is gericht op verdieping van de didactische kennis en vaardigheden die voor het schoolvak van belang zijn. Er is aandacht voor toetsing binnen het vak, voor ICT gebruik en probleemoplossen.
- Ontwerpstudio minor (3 EC)
  In Ontwerpstudio werk je samen met andere minorstudenten aan leermateriaal voor een projectweek waarbij de integratie van verschillende schoolvakken centraal staat.
- Schoolpracticum onderbouw (7 EC)
  Het schoolpracticum onderbouw is een stage in het vmbo-t of de onderbouw havo/vwo. Je geeft tijdens deze stage minstens 40 lessen.

Na de minor

Als je de minor van 30 EC met het niveau “startbekwaam” hebt afgerond, dan kun je na het behalen van je bachelordiploma met een onderbouw lesbevoegdheid op zak direct aan de slag als docent in het vmbo-t of de onderbouw van havo en vwo. Als je na de minor Leren Lesgeven de eerstegraads lesbevoegdheid wilt halen in een van de bètavakken, dan is de masteropleiding Educatie en Communicatie in de Bètawetenschappen (M-ECB) geschikt voor jou. Je kunt deze master direct na je bachelor of, in verkorte vorm, als tweede masteropleiding volgen. Je minor geeft je daarbij recht op vrijstellingen. Met de 30 EC variant kun je met nog eens 30 EC educatieve vakken de eerstegraads bevoegdheid halen naast (of gedeeltelijk geïntegreerd in) je eigen technische masteropleiding. Als je de eerstegraads lesbevoegdheid wilt halen voor maatschappijleer en maatschappijwetenschappen, dan is de master Educatie in de Mens- en Maatschappijwetenschappen (M-EMM) interessant. Voor economie en M&O is de doorstroom naar de eerstegraads bevoegdheid aan een andere universiteit een optie. Voor de toelating tot de masteropleidingen kan een schakeltraject nodig zijn, als de vooropleiding contentselijk niet voldoende aansluit.

Personal Experience – Nikki van de Rijdt – Leren Lesgeven

- Welke minor heb je gevolgd?

Minor Leren Lesgeven (30EC) in module 1 en 2 van collegejaar 2017-2018.

- Waarom heb je besloten deze minor te kiezen?

Ik wilde graag iets anders doen dan de standaard richtingen procestechnologie en materiaalkunde. Doordat ik bijlessen heb gegeven in scheikunde kwam ik erachter dat ik het uitleggen van de scheikunde stof erg leuk vind. Als aansluiting hierop wilde ik graag kennis maken met het 'docent zijn'. Deze minor was hiervoor een laagdrempelige mogelijkheid.

- Hoe is de minor bevallen?

Ik vond de module erg leuk en leerzaam. De kennis die je opdoet bij de vakken onderwijskunde en vakdidactiek kun je meteen in de praktijk toepassen tijdens je stage. Dat vond ik een pluspunt en dat maakte de vakken direct erg nuttig. Het vak ontwerpstudio in het tweede deel van de minor vond ik minder, omdat dit niet direct toepasbaar was en de tijd die ervoor stond was niet voldoende om een product te maken van goede kwaliteit. Dit was de eerste keer dat dit vak in de minor werd gegeven en de feedback van dit jaar zal meegenomen worden voor de volgende keer.
Verder zit de module heel overzichtelijk in elkaar en is het vanaf het begin af aan duidelijk wat er verwacht wordt. Om de module goed af te sluiten is het ook wel nodig om vanaf het begin te doen wat er verwacht wordt.

- Wat is de tijdsbesteding voor de minor en hoe moeilijk heb jij deze ervaren in vergelijking met ST?

Mijn ervaring is dat deze minor erg veel tijd kost. Veel zaken moet je gewoon doen (zoals stagelopen en opdrachten maken). Dit kost tijd, maar is niet bijzonder moeilijk.

- Hoe was de aansluiting op ST, had je genoeg voorkennis en kun je de kennis die je tijdens de minor hebt vergaard bij ST gebruiken?

Ik had voldoende voorkennis vanuit ST om de minor te volgen. Er is zeker wel wat kennis die ik vanuit ST hebt geleerd die ik kon gebruiken in de module, maar veel was ook nog bekend van de middelbare school. Verder heb ik tijdens deze module hele andere soort kennis en vaardigheden geleerd dan ik gewend was bij ST en dat vond ik juist leuk.

Groetjes,

Nikki van de Rijdt

Minor abroad

If you decide that you want to see more of the world, you can apply for a minor abroad. Every academic year over 700 students participate in international exchange, internship or study tours abroad. Meeting new people, experiencing new cultures and learning a foreign language are the main reasons for students to spend time abroad during their studies. In addition, an international experience broadens your horizon and contributes to your personal development.

Keep in mind it may take six to twelve months to take all necessary preparations for study or internship abroad, so you are advised to start planning well ahead of time. Always contact your faculty contact person for (programme) specific information about study and internship abroad.

The deadline for applying for a minor abroad in 2018 has already passed, but we have included some experiences from students to provide inspiration for the years to come.

Hanna Reijneveld – Nanotechnology in Lodz – Poland

I wanted to use my minor to see if I would like the master nanotechnology. For this reason I looked into different universities that had nanotechnology courses. During a presentation from the university of Lodz they told that nanotechnology courses could be combined with a project. This was interesting for me because many universities do not offer enough courses to complete a semester. I stayed in Lodz from halfway through September till the beginning of February. The quality of education is not very high, some things I already had in my bachelor and my project was not very challenging at the beginning, however this would increase over time. I did two small courses concerning nanometals and introduction to nanotechnology and a big project about nanocatalysts. The courses were in Polish, but I could do them in my own time with some adjustments to the course (no exam, but I had to make several small papers of two pages). They offer courses in English at the International Faculty of Engineering, but I was not at that faculty. However, those courses also do not have a very high quality of education.

Housing is offered by the university, if you choose to do that, or you can find your own place. The rent of the (shared) rooms by the university is around 110 euros, apartments in the city are often somewhat more expensive (200 euros or more). Transportation is very cheap, taxis costs not so much and you can also rent bikes for free for 20 minutes (after that 25 cents per hour). However, this stops in the beginning of December (with the first snow). Besides cheap transport, food is also cheap. I went out for dinner at least two times a week and still spend about a third less compared to in the Netherlands. It is good to know that in the university rooms you have to buy your own cooking equipment which is one of your biggest expenses in the beginning. Most Polish people do not speak English, but the university offers a Polish language course before the beginning of the semester. This course takes two weeks and you can get ECs for it, and you really learn some basic ‘survival’ Polish. This course is also very nice to meet people and to get acquainted. Besides using the polish course to meet people, also the activities of the ESN network can be nicely used to meet people. They organize some trips and many other activities (often related to drinking).

If you want to gain new knowledge during your minor, Lodz is not a good destination due to their quality of education. However, you meet a totally different culture and learn to be more flexible regarding basically everything, from meetings to deadlines to courses. Also, the student group is really great and you meet a lot of different people from different countries (many Spanish people).

Hanna Reijneveld

h.m.reijneveld@student.utwente.nl

Minor at CityUniversity Hong Kong – Marjolijn Katerberg

In 2016-2017 in the fall semester I followed my minor in Hong Kong. I had such a great time in Hong Kong, with a lot of time for self-exploring, meeting inspiring people, having good discussions, getting to know a new culture and appreciate things more at home (cliché, but true). For me it was a perfect break in my life in Enschede.

Hong Kong is cool, because it's a biiiiig city and I was never in this busy cities before. There is a kind of west meets east culture, so not the biggest culture shock possible. Also nice in Hong Kong is the climate, in the time I was there it was very humid in the beginning, around the 30 degrees and towards the end it was 20 degrees. Not so rainy and a lot of sun ☺ When you like beaches, there are a lot of nice beaches, most around the 2 hours traveling from university. When you like hiking, there are a lot of opportunities for nice hikes in Hong Kong. When you like partying, there are always new parties organized and you can often find them easily via Facebook. When you like shopping, you are on the perfect place. In short, I would everyone recommend going on exchange.

Courses
There are many courses you can choose. All my courses were arranged at two days in the week. Next to this, I needed to study for about 1-2 days more a week, so I had a lot of leisure time. Don't be afraid to follow (difficult) courses abroad, in most countries the level of education is lower than in the Netherlands.

- Biochemistry of Attraction: this course is open to everyone and this results in quite a low level. It was given by a professor from Germany and there was a nice field trip included. The course was about hormones and behaviour, mostly about animals other than human, but also human species is discussed.
- Atmospheric Chemistry: this was a course in the School of Energy and Environment and the most difficult one that I took. But it was so interesting. I would everyone recommend to take this course if possible. It gives good insights in air pollution, climate change and environmental policies. The professor was from Australia and he is one of the best professor I've ever had.
- Astronomy - the sky and us: this course was disappointing. The professor could not explain the very interesting topics in this field. The level could not be high, because every student could drop in, but it should still be possible to make students enthusiastic about dark matter, other universes and star dust.
- History of Sound and Noise: this was a course I took in Creative Media Centre and it was a fun course. The professor was really good in this field and let every student think about how to write sound during the whole week. I was impressed by this, because in other courses, you are usually not thinking about the problems during the whole week. Every lesson was very creative and enjoyable.
- Nobel Prize – Human Achievements: this course was really interesting and not a course that you would possibly attend at other universities. It was a kind of philosophical course: how can people achieve high goals? What makes a person great? What is peace? Again, I was thinking about the philosophical questions all during the week. The lessons itself were sometimes less good, because the professor was talking a lot and there could have been more interaction.

When there are questions about the courses I followed or things you need to arrange before going abroad, don't bother to ask.

Marjolijn Katerberg