# Master of Science in Engineering - Sustainable Product Creation

## Semester 1

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<th>Course</th>
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<th>Exercise (UE)</th>
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## Semester 2

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Semester 1

**Project management**

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<td>ECTS:</td>
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<tr>
<td>Language:</td>
<td>Anglais</td>
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<tr>
<td>Mandatory:</td>
<td>Oui</td>
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<tr>
<td>Evaluation:</td>
<td>As the learning happens during the workshop, the attendance to all the days is mandatory to be accepted to the exam.</td>
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<tr>
<td>Professor:</td>
<td>GANTENBERG Martin Dirk</td>
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**Sensors & signal processing**

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<tr>
<td>Mandatory:</td>
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**Assessment of Finite Element Calculations**

<table>
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<tr>
<td>ECTS:</td>
<td>3</td>
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<tr>
<td>Course learning outcomes:</td>
<td>On completion of the course unit successful students will be able to:</td>
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The student is enabled to use and understand a well-established norm [1] for analytical strength assessment of components based on local stresses calculated with the help of the finite element method.

As this norm is well known in industry and research (6 th edition), its use and the respective background are detailed in this lecture. The student understands why the norm imposes a specific procedure for static and a different one for fatigue assessment and what the relevant influence factors are. All important background information is given by two classical textbooks [2], [4], multiple handouts and three discussed examples. The additional information deploys
the relevant physical background phenomena quantitatively, where the norm is short. Vice-
versa, the textbooks etc. do not contain numerical quantity values for direct use, what the only
norm does.

Description:

Lecture 1: Introduction to the problem (General survey of FKM, Chapt. 0, [1]) and by discussion
of an analytical example: stress distribution in a thick walled pressurized tube. Repetition of
principle stresses and three stress hypotheses for combined stress. Difference between Fatigue
Assessment and Fracture Mechanics (1.handout 7 pages, fracture mechanics not part of this
lecture), definition of local and nominal stresses (assessment by use of nominal stresses is not
part of this lecture).

Lecture 2: Definition of local, uniaxial, multiaxial, proportional, synchronous and non-proportional
stresses. Procedure of calculation and demarcation with respect to nominal stresses, repetition
of basics: effect of notches, stress concentration factor SCF or Kt

Lecture 3: Chapt. 3.0 – 3.1.2.2 of FKM [1]: combined stress in case of brittle and ductile
material, multiaxiality, repetition of basics: stress-strain curve, simplification of elastic-ideal
plastic behavior, hardening, real stress and real strain, yield-curve of a component, (2.handout
1 page, reinforced concrete), section factor, stress and strain distribution of a smooth specimen
subject to bending, NEUBER equation with example (3.handout 1 page), plastic strain limits vs.
elongation at break, plastic limit loading.

Lecture 4: Chapt. 3.1.2.2 – 3.2.1.2 of FKM [1] : effect of thickness and repetition of basics: plain
stress state and plain strain state, full plasticity and collapse loading, effect of pre- or residual-
stress for brittle and ductile material, loading and unloading, reverse-plastification, (4.handout 1
page, effect of post-weld-heat-treatment)

Lecture 5: Chapt. 3.2.1.2 – 3.6.1.2 of FKM [1]: effect of thickness, elevated temperature including
creep (5. handout 2 pages), section factor n plof FKM based on NEUBER rule, plastic notch
factor and strain limit, typical safety factors and assessment incl. multiaxiality; definition of stress
categories: primary & secondary, membrane, bending & peak stresses only to dermark from
ASME-code approach (not part of the lecture), repetition of basics: failure load of brittle and
ductile material, Charpy-impact testing.

Lecture 6: Chapt. 4.0 – 4.1.3.1 of FKM [1] : s-n-line, stress ratio R, stress spectrum, endurance
limit, slope k, and repetition of basics: cyclic loading, proportional, synchronous and non-
proportional loading, finite life and endurance limit, stress-range R and the s-n-line (Wöhlerline),
’slope’ of the s-n-line, knee point, typical scatter T nand T svalues, statistics of cyclic testing and
normalized s-n-line

Lecture 7: Chapt. 4.1.3.1 – 4.1.3.2 of FKM [1] : constant amplitude s-n-curve, mean stress
influence, and repetition of basics: alternating and pulsating loading, endurance strength limits
for different materials and loadings, effect of mean stress- Haigh and Smith diagram, mean
stress sensitivity, simplified Haigh diagram acc. to FKM, static limits of the Haigh-diagram, effect
of surface, size, stress gradient (or volume) and corrosive environment on the endurance limit,
effect of notches, definition of fatigue notch factor Kf vs. form factor Kt (=SCF), dynamic support
factor= Kt - Kf-ratio

Lecture 8: Chapt. 4.1.3 – 4.6.2.2 of FKM [1]: influence of mean stress and variable amplitude,
fatigue limit=endurance limit, temperature influence, 6. handout 1 pages to repeat support factor=
Kt - Kf-ratio, related stress gradient, design factor KWK, mean stress factor KAK, variable
amplitude fatigue strength factor KBK, the different fields of the HAIGH diagram, two simplified
models of s-n-lines, Miner’s elementary and consistent rule, damage sum, degree of utilisation, stress spectrum and its determination by rainflow- and rainfill-reservoir-counting (example with 7. handout -5 pages )

Lecture 9: First full example, based on our open access-peer-reviewed publication [3] (8 . handout - 7 pages )

Lecture 10: Chapt. 6.0 – 6.2.2 of FKM [1]: Discussion of two fully detailed examples in the annexe of FKM

Lecture 11: ANSYS-Workbench, computer room: introduction into the software, modelling of a thick walled tube

Lecture 12: ANSYS-Workbench, computer room: 9 . handout, send by email – geometry of first example, ref. to lecture 9 )

Lecture 13: ANSYS-Workbench, computer room: full linear and non-linear calculation acc. to FKM for the example of lecture 9, repetition and summary of theory (10 . handout - 7 pages )

Teaching modality: Lectures + tutorials
Language: Anglais
Mandatory: Oui
Evaluation: Written exam
Remark: 2. Literature / Littérature / Literatur


[4] Issler, Ruoss, Häfele, Festigkeitslehre – Grundlagen, Springer, ISBN 3-540-40705-7 10 handouts during the lectures (in English)

Professor: MAAS Stefan, SELLEN Stephan

Matlab Programming for engineers

Module: Matlab Programming for engineers (Semester 1)
ECTS: 3
Objective: This course introduces basic methods, algorithms and programming techniques to solve mathematical problems. The course is designed for students to learn how to develop numerical
methods and estimate numerical errors using basic calculus concepts and results, as well as writing programs to implement the numerical methods with the Matlab software package.

**Course learning outcomes:**

Having successfully completed the module, students will be able to demonstrate knowledge and understanding of:

1. Numerical methods to solve systems of linear equations;
2. Numerical methods to compute quadratures;
3. Numerical methods to solve ordinary differential equations;
4. Numerical methods to solve simple partial differential equations;
5. Write Matlab programs, to solve the above problems.

**Description:**

1. Nonlinear equations
2. Linear systems
   a. Matrix equations
   b. Eigenvalue problem
3. Curve fitting and interpolation
4. Numerical differentiation
5. Numerical Integration
6. Ordinary Differential Equations
   a. Initial value problem
   b. Boundary value problem
7. Partial Differential Equations (PDEs)
   a. Basic theory, simple PDEs (Poisson, Heat, Wave).
   b. Numerical solutions of PDEs.
8. Matlab
   a. Introduction, commands to solve integration problems and ordinary and partial differential equations.
   b. Basic programming techniques.

**Teaching modality:** Lecture

**Language:** Anglais

**Mandatory:** Oui

**Evaluation:** Homework, Presentation, and Exam.

**Professor:** HICHRI Bassem
Machine design

Module: Machine design (Semester 1)
ECTS: 4
Objective: The aim of the course is:

- to deepen knowledge of designs of machine elements gained in the courses of machine element in bachelor study
- to present advanced design methods of mechanical parts
- to introduce advanced tools (CAE) of analyses of machine design: FEA – ANSYS/ Inventor, CAD – Inventor, reporting/ calculations – Mathcad, and Fusion 360 - CAD cloud computing

...to build base student knowledge of machine design, which is needed for their projects in semester 2 - Machine Design Exercise.

Course learning outcomes:
After the course, the student:

- is able to carry out a design process of mechanical objects
- uses in practice analytical equations of mechanics to design machine elements
- solves real technical problems using previously acquired knowledge of subjects: mechanics, strength of materials, machine element design, and CAD
- is able to propose an appropriate technological process of manufacture and assembly for a particular machine element
- knows how to utilise CAE tools like ANSYS, Inventor, and Mathcad in design projects
- is able to understand the concept of the machine element optimisation and employ this method in projects.

Description:
1. Part I Fundamentals
   - Tolerances and fits. Deviations of form and position and surface roughness
   - Loads, analysis, materials, static body stresses
   - Fatigue and impact
   - Safety factor, reliability
2. Part II - Machine Elements
   - Stresses and deformations in cylinders
   - Shafts and associated parts
   - Bearings
   - General gear theory
§ spur sears, helical, bevel and worm gears

- Manual gearboxes designs
- Brakes and clutches
- Flexible machine elements

§ belts, wire ropes, rolling chains

Machine element optimisation

**Teaching modality:** Lecture and practical exercises

**Language:** Anglais

**Mandatory:** Non

**Evaluation:** 50% written exam + 50% project assignments

**Remark:**
- Course materials available on Moodle system?
- "Fundamentals of Machine Components Design ", R. C. Juvinall, Kurt M. Marshek

**Professor:** KEDZIORA Slawomir

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**Supply Chain and Logistics**

**Module:** Supply Chain and Logistics (Semester 1)

**ECTS:** 4

**Objective:**

- Provide knowledge and insight into supply chain systems as a whole (manufacturing, distribution, retail and customer demand)
- Identify the critical infrastructure for production and distribution
- Understand uncertainty and decision making issues in logistics and supply chain management (eg. make-or-buy, competition, collaboration strategies)
- Understand the effect of different management policies (information, control, contracting, outsourcing etc.)
- Provide conceptual, analytical and numerical tools for modeling and solving logistics and supply chain applications
- Understand the concept of closed-loop supply chain systems and reverse logistics and their impact on sustainability
- Give insight into network economics and system dynamics in supply chains.
Course learning outcomes:
1. Provide the student with a basic knowledge of logistics and supply chain systems, what are the relations between the different players, and how these systems work from supplier to customers.
2. Learn how to manage complex networks and how to organize efficient and sustainable distribution logistics in order to maximize the overall profit and sustainability in the system.

Description:
- SCM introduction & strategic fit
- Logistics system dynamics incl. simulation "Beergame"
- Supply chain coordination and integration
- Supply chain network design, transport and distribution
- Forecasting & Sales and Operations Planning
- Capacity/inventory management & MRP
- SCM contracting for performance
- Sustainability, closed-loop supply chains and reverse logistics
- Procurement process & strategy
- Outsourcing/Risk Management and Supplier Development
- Innovations in Logistics and SCM
- Case studies
- Exercises as homework

Themes:
1. The complexity of modelling supply chain and logistics networks is elaborated in detail, from the production phase to final delivery to markets and customers and how they get to equilibrium; emphasis is given to the costs, large savings and environmental improvements that can be obtained with efficient supply chain management and when integrating the product creation and movement along the chain.
2. Different management solutions are described in the second part of the course to learn how to reduce distribution logistics costs, limit supply chain dynamics, improve sustainability and finally maximize profits.

Language: Anglais
Mandatory: Oui
Evaluation: Written examination, 90min
Remark: Literature:

Articles from literature/ hand-outs

Professor: KORNE Thomas Bert
# Production technologies and Industrial Management

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<td>ECTS:</td>
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<tr>
<td><strong>Objective:</strong></td>
<td>Introduce the broad range of production technologies which are used in modern manufacturing industry, comprehend the impact of manufacturing to cautious use of resources (like energy, raw materials and floor space) and realize the opportunities for sustainable use of resources through early interaction with product designers.</td>
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<td><strong>Course learning outcomes:</strong></td>
<td>The students will know all relevant manufacturing technologies and the related strength and understand weaknesses, especially in regard to sustainable use of resources. The students will Identify, formulate, and solve manufacturing engineering issues under energetic and economic constraints. For example to produce light weight product out of CFRP or to develop for energy saving machines with limited use of compressed air the students will know state-of-the art manufacturing technologies to produce modern products. They will understand opportunities of manufacturing to limit usage of energy, material and other resources. The students will understand the impact of manufacturing on cost, quality and energy.</td>
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| **Description:** | These production technologies and their specific use of resources will be discussed:  
  · Primary shaping (Casting, sintering, extruding, ..)  
  · Forming (Massive forming and sheet metal forming,..)  
  · Cutting (Turning, Milling, Grinding, EDM, …)  
  · Coating (Painting, Anodizing, Physical Vapour deposition,..)  
  · Laser technology  
  · Additive Manufacturing  
  · CNC Machines and Controls  
  · Development of production processes and implementation of machines  
  · Assembly time prediction based on Methods Time Measurement · Organization of industrial production |
| **Teaching modality:** | Lectures |
| **Language:** | Anglais |
| **Mandatory:** | Non |
| **Evaluation:** | Written exam |
| **Professor:** | PLAAPPER Peter |
Life Cycle Assessment and Eco Design

Module: Life Cycle Assessment and Eco Design (Semester 1)
ECTS: 3

Objective: Students of this course learn to design products/megastructures following the principles of sustainability. For that, students get to know what sustainable products and sustainable resources can mean. Additionally, students understand how a product's performance for sustainability can be assessed in order to critically reflect on it. Particularly, the course aims at enabling students to apply life cycle assessment (LCA) and eco-design methods.

Course learning outcomes: After successfully participating in the course, students will be able to

1.) independently improve the environmental performance of their products/megastructures and developing sustainable product concepts by applying eco-design strategies, principles and methods in the early stages of the development process,

2.) integrate the ecological perspective in the technical product creation,

3.) critically analyze LCA studies, and

4.) conduct their own LCA studies.

Description: The course includes a mix of lecture, individual and group work exercises, discussions and feedback sessions. Students work on one assignment and present it in the course. In addition to the final examination, this assignment contributes to the rating of students.

The content of the course focusses on the following main areas:

- Introduction to sustainable development and related concepts such as circular economy and planetary boundaries.

- The importance of life cycle thinking/management for engineers from a business perspective in the context of sustainable development

- The life cycle of products and megastructures

- Environmental impacts of products and megastructures and their indicators

- Examples of eco-designed products

- Eco-design strategies, principles and methods

- Limitations of eco-design

- The importance of LCA

- (Manual) calculation of LCA
Master of Science in Engineering - Sustainable Product Creation

- Software tools
- Practical issues of LCA
- Critical review of LCA studies (assignment)
- Extensions of LCA through planetary boundaries and Life Cycle Benefit Analysis
- LCA and eco-design in early stages of the development process

**Teaching modality:** Lecture
**Language:** Anglais
**Mandatory:** Oui
**Evaluation:** Written Examination

**Remark:**
- Vezzoli, C; Manzini E: Design for Environmental Sustainability. Springer 2008

**Professor:** WALTERSDORFER Gregor

### Networking

**Module:** Computer Networking (Semester 1)
**ECTS:** 3
**Objective:** Introduce higher networking layers and mathematical descriptions of network concepts as Multiple Access Control (ALOHA, collision detection and resolution), Error detecting and correcting codes, ARQ, routing and flow control, Queueing and QoS.

**Description:**
- Hierarchical Model of Network Functions (OSI Model, Service Access Points)
- Point-to-Point Data Transmission (synchronous and asynchronous multiplexing, packets)
- Error correcting and detecting codes, ARQ protocols
- Multiple Access Control (ALOHA, Slotted ALOHA, collision resolution, detection and avoiding)
- Routing and flow control
- Introduction to Queueing Theory
- Mobile Network Access Schemes
- Quality of Service Access Parameters in TCP/IP
Master of Science in Engineering - Sustainable Product Creation

Teaching modality: The course consists of a series of lectures with dedicated time slots for exercises
Language: Anglais
Mandatory: Non
Evaluation: There is a final exam counting 70%. Successful preparation, submission and participation in exercises is valued 30%
Professor: ENGEL Thomas

Communication Theory

Module: Communication Theory (Semester 1)
ECTS: 3
Objective: Provide mathematical fundamentals of the physical layer like stochastic signals and systems, ML and MAP principle, modulation, and channel models.
Course learning outcomes: * Describe fundamental parameters of signals, systems, and channels
* Take optimal stochastic decisions based on observations
Description: * Signals and Systems
* Convolution
* Sampling
* Stochastic Signals and Noise
* Modulation and Demodulation
* The Maximum Likelihood Principle
* Sources and Channels
Teaching modality: * Review of Stochastic Signals and Systems
* Digital Transmission and Modulation
* Demodulation
* Channel Models
* ML Principle
* Matched Filter
* Equalization
Language: Anglais
Mandatory: Non
Evaluation: Final Exam (100%)
Professor: SORGER Ulrich
### Product Planning & Marketing for Engineers

**Module:** Product Planning & Marketing for Engineers (Semester 2)  
**ECTS:** 3  
**Objective:** The students understand the importance of market oriented product design.  
They know marketing terminology and methods.  
They can prepare decisions to target specific market segments.  
**Course learning outcomes:** The students will be able to develop a compelling marketing strategy of their engineering product or service. They understand the importance of considering customer needs in the engineering design and reflect buying power of the customers.  
**Description:**  
- Basic concepts of marketing  
- Market planning  
- Development of marketing strategies  
- Market research  
- Product strategies  
- Pricing  
- Advertising, Sales and Marketing  
- Business plan for a start-up  
Case studies will enable the students to apply the learned competencies.  
**Language:** Anglais  
**Mandatory:** Oui  
**Evaluation:** 20% presentation and class participation and 80% exam  
**Professor:** KÖNIG Tatjana

### Managerial Accounting

**Module:** Managerial Accounting (Semester 2)  
**ECTS:** 3  
**Objective:** This course is an intensive introduction to the preparation and interpretation of financial information for investors (external users) and managers (internal users) and to the use of financial instruments to support system and project creation.  
The course adopts a decision-maker perspective on accounting and finance with the goal of helping students develop a framework for understanding financial, managerial, and tax reports.
The course will also explore how cost-volume-profit relationships and incremental analysis provide managers the information to support their decision-making.

Course learning outcomes:

This course will enable you

- To acquire an overview of the use of accounting data by managers for financial and operational planning and control.
- To evaluate the organizational role of management accountants and describe accounting systems used by manufacturing businesses.
- To acquire a basic knowledge in the techniques and procedures of costing systems, profit planning, and the collection and use of cost data in decision making.
- To develop a basic foundation in the concepts of cost behaviour and cost systems design.
- To understand basic managerial and cost accounting concepts such as cost-volume-profit, budgeting, product costing and cost behaviour.
- To prepare, use and evaluate budgetary data.
- To evaluate capital expenditure decisions using discounted cash flow.
- To analyze Capital Investment Alternatives.
- To apply and interpret basic financial statement analysis.

Teaching modality: The course will be delivered online through a series of Webinar lectures, slide presentations, case studies, and on-going participation in discussion forums.

All lecture slides, Connect Account/Submission assignments and forum topic participation requirements will be provided on a weekly basis. Each student should consult the Moodle platform daily for announcements.

Language: Anglais

Mandatory: Oui

Evaluation: Assessment will be based on Weekly Connect/Submission Assignments (10% or 12pts), Weekly Participation in Forums (10% or 12pts), Group Case Studies (10% or 12pts), a Midterm Exam (20% or 24pts), and the Final Exam (50% or 60pts).

Weekly Assignments

All weekly assignments will be communicated with a view that enough time is given for the work to be completed. Instructions on your forum participation, Connect account/submission requirements will be communicated. The Weekly Connect/Submission assignment is 20% or 24pts and the Forum Participation is also 20% or 24pts of the total assessment score.

Group Project

Case Studies in groups will be assigned. 10% or 12pts of the total assessment score.
Midterm Test

The midterm Test will be a summary review of the weekly assignments based on textbook chapters and material covered in class. The midterm exam will take place online and will be 20% or 24pts of the total assessment score.

Final Exam

The final exam will be a summary review of the weekly assignments based on textbook chapters and material covered in class. The final exam will take place on campus and will be 50% or 60pts of the total assessment score.

Attendance

Attendance is part of the forum participation mark. 80% of lecture attendance on courses is compulsory for obtaining the ECTS units related to that course and module. Attendance is recorded as meeting the forum participation rule of 2 separate posts 2 times per week.

Note: Instructor reserves the right to change the Weekly Assignments, the Group Project or Quizzes during the semester.

Remark: Required Tex:


with Connect Account: ISBN-13 9780071221085

Indicative Reading:

Illustrative texts and articles include:

· C Horngren, A Bhimani, S Datar & G Foster, Management and Cost Accounting, FT/Prentice Hall (2008)
· A. Bhimani, Contemporary Issues in Management Accounting, Oxford University Press (2006)
· Emsley, Redesigning variance analysis for problem solving, Management Accounting Research (2001) pp.21-40
· Davila, T. and Wouters, M. (2005) "Managing budget emphasis through the explicit design of conditional budgetary slack", Accounting, Organizations and Society: 30, 587-608

Professor: MULLI James
## Assembly and testing technologies - old

**Module:** Assembly and testing technologies (Semester 2)

**ECTS:** 3

**Objective:** The student will understand assembly technologies, related material handling functionalities, gripping techniques and the linkage to logistics. They can evaluate product design for assembly. The students know machinery and equipment for manual and automated assembly processes and are aware about the specific opportunities and limitations.

**Description:**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extended V- process of product development</td>
<td>2</td>
</tr>
<tr>
<td>Main preconditions of product assembly</td>
<td>2</td>
</tr>
<tr>
<td>Object oriented analysis of assembly and test equipment</td>
<td>2</td>
</tr>
<tr>
<td>Machine and process availability</td>
<td>3</td>
</tr>
<tr>
<td>Design and process FMEA</td>
<td>2</td>
</tr>
<tr>
<td>Gauge, machine and process capability</td>
<td>2</td>
</tr>
<tr>
<td>Quality management, worker security, ergonomics</td>
<td>2</td>
</tr>
<tr>
<td>Structure of vehicle production final assembly area</td>
<td>2</td>
</tr>
<tr>
<td>Logistic, conveyor technologies</td>
<td>2</td>
</tr>
</tbody>
</table>
Fixation technologies
Bolting principle and process

Rear axle manual and automatic assembly and setting station
Simulation and virtual commissioning

Marriage station and palettes

Electric- and electronic testing, ECU communication
NHV testing

Wheel alignment
Sensor technologies, calibration, manual and automatic setting

Head lamp setting
Light box and image processing, calibration, setting

Driver assistance systems (DAS) setting
DAS sensor technology and corresponding testing and setting methods

Brake- and combined roll-, brake-, ABS-test rig
Measurement technology calibration
Assembly and testing technologies - new

Module: Assembly and testing technologies (Semester 2)
ECTS: 4
Objective: The student will understand assembly technologies, related material handling functionalities, gripping techniques and the linkage to logistics. They can evaluate product design for assembly. The students know machinery and equipment for manual and automated assembly processes and are aware about the specific opportunities and limitations.

Description:
Subject

Hours

Extended V- process of product development

Main preconditions of product assembly

2

Object oriented analysis of assembly and test equipment

2

Machine and process availability

Design and process FMEA

2

Gauge, machine and process capability

2
Quality management, worker security, ergonomics

2

Structure of vehicle production final assembly area

Logistic, conveyor technologies

2

7

Fixation technologies

Bolting principle and process

2

8

Rear axle manual and automatic assembly and setting station

Simulation and virtual commissioning

2

9

Marriage station and palettes

2

Electric- and electronic testing, ECU communication

NHV testing

2

Wheel alignment

Sensor technologies, calibration, manual and automatic setting

3

12

Head lamp setting

Light box and image processing, calibration, setting

13

Driver assistance systems (DAS) setting
Programming for engineers - old

Module: Programming for engineers (Semester 2)
ECTS: 3
Objective: The aim of the course is to teach basics of programming with modern languages (Java/Python/C#), software engineering and applications of data analytics and visualization for engineers. The students can practically apply what they have learned in assignments and students projects.

The course consists of the following learning units:

· Introduction to programming
· Concepts of programming such as object orientation
· Principles of software development and UML
· Introduction to data analytics
· Data visualization

Course learning outcomes: Having successfully completed the module, students will be able to demonstrate knowledge and understanding of:

· Programming algorithms for solving tasks in engineering;
· Using modern tools and methods for software development;
· Being able to process different data sets and
· Utilize visualization methods on large data records.

Description: 1. Concepts of programming languages (week 1 and 2)
2. Elements of programming languages such as statements, operators, loops, variables, simple types, complex types (week 3 and 4) 3. Concepts of object oriented programming, i.e. classes, objects, methods, polymorphism (week 5 and 6)

4. Software design with UML (week 7 and 8)

5. Data structures and data visualization (week 9 and 10)

6. Business analytics (week 11 and 12)

7. Course project (week 13, 14 and 15)

Teaching modality: Lecture
Language: Anglais
Mandatory: Oui
Evaluation: Written or oral exam.
Remark: "Python for Everybody"; "Python for Informatics"; both by Charles Severance
Professor: MINOUFEKR Meysam

Programming for engineers - new

Module: Programming for engineers (Semester 2)
ECTS: 4
Objective: The aim of the course is to teach basics of programming with modern languages (Java/Python/ C#), software engineering and applications of data analytics and visualization for engineers. The students can practically apply what they have learned in assignments and students projects.

The course consists of the following learning units:

- Introduction to programming
- Concepts of programming such as object orientation
- Principles of software development and UML
- Introduction to data analytics
- Data visualization

Course learning outcomes: Having successfully completed the module, students will be able to demonstrate knowledge and understanding of:

- Programming algorithms for solving tasks in engineering;
- Using modern tools and methods for software development;
- Being able to process different data sets and
- Utilize visualization methods on large data records.

### Description:

1. Concepts of programming languages (week 1 and 2)
2. Elements of programming languages such as statements, operators, loops, variables, simple types, complex types (week 3 and 4)  
   - Concepts of object oriented programming, i.e. classes, objects, methods, polymorphism (week 5 and 6)
3. Software design with UML (week 7 and 8)
4. Data structures and data visualization (week 9 and 10)
5. Business analytics (week 11 and 12)
6. Course project (week 13, 14 and 15)

### Language:

Anglais

### Mandatory:

Oui

### Evaluation:

Written or oral exam.

### Remark:

"Python for Everybody"; "Python for Informatics"; both by Charles Severance

### Professor:

MINOUFEKR Meysam

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### Digital Factory Planning

<table>
<thead>
<tr>
<th>Module</th>
<th>Digital Factory Planning (Semester 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECTS</td>
<td>3</td>
</tr>
<tr>
<td>Teaching modality</td>
<td>1 week of workshop</td>
</tr>
<tr>
<td>Language</td>
<td>Anglais</td>
</tr>
<tr>
<td>Mandatory</td>
<td>Oui</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Mandatory attendance to the workshop - assessment at the end of the workshop</td>
</tr>
</tbody>
</table>
### Robotics

**Module:** Robotics (Semester 3)  
**ECTS:** 4  
**Objective:** Student understands principles of robots and is able to integrate robots in production concepts to avoid ergonomic stress for humans and enhance productivity.  
**Course learning outcomes:** The student will understand main robotic architectures and related kinematics. Knows state of the art programming techniques. Student is able to plan application of industrial robots. The student has basic capability to program industrial robots.  
**Description:**  
1. Types of industrial robots and handling devices  
2. Cooperative mobile robots  
3. Actuators and Sensors (drives, manipulators and sensor systems)  
4. Kinematics and dynamic model (coordinate Transformation)  
6. Robotic control systems  
   - Hardware  
   - Software  
7. Safety considerations  
8. Programming of industrial robots (online, offline, CAD oriented programming)  
9. Motion planning and collision avoidance  
10. Organizational and economic aspects (Productivity and impact to labour)  
11. Applications, planning techniques (preparing the installation & launch)  
12. Selected case studies of robotic applications  
**Language:** Anglais  
**Mandatory:** Oui  
**Evaluation:** Written Exam / test  
**Professor:** HICHRI Bassem

### Lean Six Sigma - Green Belt

**Module:** Lean Six Sigma - Green Belt (Semester 3)  
**ECTS:** 3  
**Language:** Anglais  
**Mandatory:** Oui
Electrical Energy Production Transportation and Distribution

Module: Electrical Energy Production Transportation and Distribution (Semester 3)
ECTS: 3
Language: Français
Mandatory: Non

Energetics of the blast furnace

Module: Energetics of the blast furnace (Semester 3)
ECTS: 3
Objective: Introduction of industrial processes to the students in order to bridge the theory of the study and the industrial application. Technical, environmental and economical aspects are discussed and the interrelationship shall become obvious.

Description: The Blast Furnace Process:
- History and description of the Blast Furnace
- The Blast Furnace Process:
  - Reduction Equations
  - Thermal and mass balance
  - Auxiliary plants (Hot Stoves, Sinter Plant, Pulverized Coal Injection Plant, Slag treatment, etc.)

Technical Improvements to the Blast Furnace Process with economical and environmental impacts:
- Top Gas Recovery Turbine
- Coal Grinding and Drying & Pulverized Coal Injection
- Slag Granulation to create a substitute for cement clinker
- Heat recovery system at the Hot Stoves

Language: Anglais
Mandatory: Non
Evaluation: Written exam
Scientific writing and presentation skills

Module: Scientific writing and presentation skills (Semester 3)
ECTS: 3
Objective: This course aims to give students the background and confidence to write effective engineering reports and papers.

They will learn the fundamentals of effective scientific and professional writing.

Presentation skills, verbal and non-verbal communication as well as specific documents such as a CV, cover letter, abstract and executive summary will be covered.

Course learning outcomes:
As a result of this course the students should be able to:

- Write an engineering or scientific paper in regards to their structure, coherence, conciseness and expressing the core idea.
- Evaluate own writing and the writing of others.
- Deliver a professional or scientific presentation.
- Write a professional CV and cover letter, as well as learn how to prepare themselves for a job interview

Description:
Section 1. Professional writing

- Professional writing and professional communication
  - The CV
  - The cover letter
  - The job interview

Section 2. Presentation skills

- Write presentations in academic and professional context
- Verbal and non-verbal communication during the presentation

Section 3. Scientific report writing

- Engineering reports
- The abstract and the executive summary

Teaching modality: Lecture
### Advanced Project / Case Study

<table>
<thead>
<tr>
<th>Module</th>
<th>Advanced Project / Case Study (Semester 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECTS</td>
<td>12</td>
</tr>
<tr>
<td>Objective</td>
<td>Purpose of the case study in the third master semester is to apply your engineering learnings but even more relevant to learn scientific work, and thus to prepare your Master project.</td>
</tr>
<tr>
<td>Description</td>
<td>To ensure the desired broad learning, we require that the case study and the Master thesis are distinct, thus you shall work on two different projects with two different supervisors.</td>
</tr>
<tr>
<td>Language</td>
<td>Anglais</td>
</tr>
<tr>
<td>Mandatory</td>
<td>Oui</td>
</tr>
<tr>
<td>Evaluation</td>
<td>written report+ 15 mins. presentation.+ 5 mins Q&amp;A</td>
</tr>
<tr>
<td>Remark</td>
<td>BE CAREFUL: In order to ensure broad education, we require Advanced Project / Case Study &amp; Master Thesis being supervised by different Professors.</td>
</tr>
</tbody>
</table>

### Operational excellence

<table>
<thead>
<tr>
<th>Module</th>
<th>Operational excellence (Semester 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECTS</td>
<td>2</td>
</tr>
<tr>
<td>Language</td>
<td>Anglais</td>
</tr>
<tr>
<td>Mandatory</td>
<td>Oui</td>
</tr>
<tr>
<td>Professor</td>
<td>PLAPPER Peter</td>
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</tbody>
</table>
Semester 4

<table>
<thead>
<tr>
<th>Master thesis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Module:</strong> Master thesis (Semester 4)</td>
</tr>
<tr>
<td><strong>ECTS:</strong> 30</td>
</tr>
<tr>
<td><strong>Language:</strong> Anglais</td>
</tr>
<tr>
<td><strong>Mandatory:</strong> Oui</td>
</tr>
<tr>
<td><strong>Remark:</strong> BE CAREFUL: In order to ensure broad education, we require Advanced Project / Case Study &amp; Master Thesis being supervised by different Professors.</td>
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</table>