Master of Science in Engineering - Sustainable Product Creation

Semester 1

	Lecture (UE)	Exercise (UE)	ECTS
Project management			4
Project management	56		4
Sensors & signal processing			3
Sensors & signal processing	30		3
Programming for engineers (Matlab & Python)			4
Programming for engineers (Matlab & Python)	45		4
Life Cycle Assessment and Eco Design			3
Life Cycle Assessment and Eco Design	45		3
Assembly and testing technologies			4
Assembly and testing technologies	45		4
Supply Chain and Logistics			4
Supply Chain and Logistics	45		4
Assessment of Finite Element Calculations			3
Assessment of Finite Element Calculations (Optional)	22	6	3
CAD & CAE			4
CAD & CAE (Optional)	39		4
Machine design			4
Machine design (Optional)	24		4
Computational Fluid Dynamics			3
Computational Fluid Dynamics (Optional)	30		3
Networking			3
Networking (Optional)	30		3

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	Lecture (UE)	Exercise (UE)	ECTS
Technical Systems Modeling and Simulation			4
Technical Systems Modeling and Simulation (Optional)	23	22	4
Communication Theory			3
Communication Theory (Optional)	30		3

Semester 2

	Lecture (UE)	Exercise (UE)	ECTS
Product Planning & Marketing for Engineers			3
Product Planning & Marketing for Engineers	45		3
Managerial Accounting			3
Managerial Accounting	36		3
Programming for engineers			3
Programming for engineers	45		4
Digital Factory Planning			3
Digital Factory Planning	0		3
Robotics			4
Robotics	0		4
Laser Technology for Manufacturing			4
Laser Technology for Manufacturing (Optional)	46		4

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Semester 3

	Lecture (UE)	Exercise (UE)	ECTS
Advanced Project / Case Study			12
Advanced Project / Case Study			12
Operational excellence			2
Operational excellence	28		2
Integrated management systems			3
Integrated management systems	45		3
Scientific writing and presentation skills			3
Scientific writing and presentation skills - MSPC	39		3
Artificial Intelligence : The course includes the following topics: 1.General introduction to Aritificial Intelligence 2.Problem resolution, search algorithms, 3.Games, alpha-beta pruning 4.Meta-heuristics, genetic algorithms, swarm algorithms 5.Constraint programming 6.Markov Decision Processes, reinforcement learning 7.Learning models for regression, classification, clustering 8.Evaluating the performance of a learning model 9.Decision trees, forests 10.Artificial neural networks 11.Unsupervised learning, k-Nearest neighbours, self-organising maps, growing neural gas			5
Artificial Intelligence (Optional)	23	22	5
Electrical Energy Production Transportation and Distribution			3
Electrical Energy Production Transportation and Distribution (Optional)	28		3
Energetics of the blast furnace			3
Energetics of the blast furnace (Optional)	30		3

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Semester 4

	Lecture (UE)	Exercise (UE)	ECTS
Master thesis			30
Master thesis		600	30

Semester 1

Project management

Module: Project management (Semester 1)

ECTS: 4

Language: Anglais

Mandatory: Oui

Evaluation: As the learning happens during the workshop, the attendance to all the days is mandatory to be accepted to the exam.

Written examination

Professor: GANTENBERG Martin Dirk

Sensors & signal processing

Module: Sensors & signal processing (Semester 1)

ECTS: 3

Language: Anglais

Mandatory: Oui

Professor: JUUL Lars

Programming for engineers (Matlab & Python)

Module: Programming for engineers (Matlab & Python) (Semester 1)

ECTS: 4

Objective:

- Understanding the MATLAB/Python environment.
- Being able to do execute codes/files using MATLAB/Python.
- Being able to carry out simple numerical computations and analyses using MATLAB and Python.

Course learning outcomes: After attending this class, the students will be able to write algorithms with functions and scripts to solve engineering problems. The students can solve mathematical problems and manipulate matrices and vectors. They will learn the differences between scripts and functions. They will learn the repetitive and condition statements. The students can build

a Graphic User Interface (GUI) They will acquire skill on data plotting, animation and 3D graphics. They will learn how to solve linear and non linear systems.

Description:

- Introduction to concepts of programming
- Datatypes and Variables
- Operators and Expressions
- Loops
- String Manipulation
- Plotting/Data Visualization in 2D and 3D
- GUI

Teaching modality: Lectures, Presentation, Coding using the software.

Language: Anglais

Mandatory: Oui

Evaluation: **4 tasks counting each for 25% of the final grade**

Task 1:

Submit a project incorporating the concepts taught during the lecture (Using Matlab)

The assessment will be done based on

- The complexity of the topic selected to submit as project
- The quality of code (efficiency, readability and executability)

Task 2:

Submit the assignment given by solving the questions (Using python)

The assessment will be done based on

- Solution submitted by the student (the technique used)
- The readability, executability and efficiency of the code)

Task 3:

Continuous assessment test taken during the lab hours (Matlab)

- Multiple choice questions will be given to be solved by the students in the stipulated time
- Each question will carry some marks depending on the difficulty level.

Task 4:

Continuous assessment test taken during the lab hours (Matlab)

- Programming questions will be given to the students to be solved in the stipulated time.
- Each question will carry some marks depending on the difficulty.
- Grades will be awarded based on the solution obtained, the quality of code and the efficiency of

the program.

Remark: **Literature & resources**

The course notes and slides provided during the lectures. Additional resources will be given during the lecture.

Professor: KUMAR Atal Anil

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
- 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: Baumann, H; Tillman, A-M: The Hitch Hiker's Guide to LCA: An Orientation in Life Cycle Assessment Methodology and Applications. Professional Pub. Service 2004

Vogtländer, J: LCA-based assessment of sustainability: the Eco-costs/Value Ratio EVR. Delft Academic Press DAP 2010

Jonker, G; Harmsen, J: Engineering for Sustainability: A Practical Guide for Sustainable Design. Elsevier 2012

Crul, M.R.M; Diehl J.C: Design for Sustainability: A Step-by-Step Approach. United Nations Environment Programme 2009

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

Professor: WALTERSDORFER Gregor

Assembly and testing technologies

Module: Assembly and testing technologies (Semester 1)

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

2

Object oriented analysis of assembly and test equipment

2

3

Machine and process availability

Design and process FMEA

2

4

Gauge, machine and process capability

2

5

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

DAS sensor technology and corresponding testing and setting methods

14

Brake- and combined roll-, brake-, ABS-test rig

Measurement technology calibration

3

Language: Anglais
Mandatory: Oui
Professor: TENTRUP Thomas

Supply Chain and Logistics

Module: Supply Chain and Logistics (Semester 1)
ECTS: 4

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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:

- Chopra, S, Meindl, P. (2016): Supply Chain Management: Strategy, Planning, and Operation, 6th ed., Upper Saddle NJ, Pearson, Boston, 2016
- Christopher, M. (2016): Logistics & Supply Chain Management, 5th edition, Harlow, Prentice Hall, 2016
- Jacobs, F. R., Chase, R. B. (2018): Operations and Supply Chain Management, 15th Global Edition, McGraw-Hill Education, New York, 2018
- Simchi-Levi, D., Kaminsky, P., Simchi-Levi, E. (2008): Designing and managing the supply chain, 3 rdedition, McGraw Hill, New York, 2008
- Van Weele, A. (2018): Purchasing and Supply Management, 7 thedition, Cengage Learning EMEA, Andover, UK, 2018

Articles from literature/ hand-outs

Professor: KORNE Thomas Bert

Assessment of Finite Element Calculations

Module: Assessment of Finite Element Calculations (Semester 1)

ECTS: 3

Course learning outcomes: On completion of the course unit successful students will be able to:

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 thedition), 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 sate 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 demark 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: Non

Evaluation: Written exam

Remark: **2. Literature / Littérature / Literatur**

[1] FKM Guideline, 6th Edition 2012, Analytical Strength Assessment of Components, ISBN 978-3-8163-0649-8

[2] Fundamentals of Machine Elements, SI Version, 3rd Edition, CRC-Press, ISBN 978-1-4822-4748-0

[3] Design rules for autofrettage of an aluminum valve body; S. Sellen, S. Maas, T. Andreas, P. Plapper, A. Zürbes and D. Becker, http://onlinelibrary.wiley.com/doi/10.1111/ffe.12328/abstract

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

Professor: MAAS Stefan, SELLEN Stephan

CAD & CAE

Module: CAD & CAE (Semester 1)

ECTS: 4

Language: Anglais

Mandatory: Non

Professor: WOLF Claude

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 proposean 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 o Tolerances and fits. Deviations of form and position and surface roughness o Loads, analysis, materials, static body stresses o Fatigue and impact o Safety factor, reliability 2. Part II - Machine Elements o Stresses and deformations in cylinders o Shafts and associated parts o Bearings o General gear theory § spur sears, helical, bevel and worm gears o Manual gearboxes designs o Brakes and clutches o 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: "Fundamentals of Machine Elements, Third Edition", Steven R. Schmid, Bernard J. Hamrock, Bo. O. Jacobson ·

Course materials available on Moodle system ?

"Fundamentals of Machine Components Design " , R. C. Juvinall, Kurt M. Marshek

" Mark's Calculations for Machine Design " , Thomas Brown.

" Shigley's Mechanical Engineering Design", Richard G Budynas, Keith J Nisbett.

" Engineering Drawing and Design", 5th Edition, David A. Madsen, David P. Madsen

Professor: KEDZIORA Slawomir

Computational Fluid Dynamics

Module: Computational Fluid Dynamics (Semester 1)
ECTS: 3
Language: Anglais
Mandatory: Non
Professor: PETERS Bernhard, AMINNIA Navid

Networking

Module: 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 Parameters in TCP/IP

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

Technical Systems Modeling and Simulation

Module:	Technical Systems Modeling and Simulation (Semester 1)
ECTS:	4
Objective:	In the seminar, techniques for modeling of technical systems are elaborated in case studies for typical technical systems employing symbolic and numeric computation methods.
Course learning outcomes:	* Build mathematical models for dynamics of technical systems derived from basic principles * Use advanced tools for numeric and symbolic computing * Apply decomposition, transformation and approximation methods * Elaborate a case study and present computational results
Description:	1 Technical Systems 2 System Structures and Model Descriptions 3 Continuous Models from Variational Analysis 4 Model Simplification 5 Optimal System Operation
Teaching modality:	The course consists half of introductional lectures, and half of practical work.
Language:	Anglais
Mandatory:	Non
Evaluation:	Final grade is composed of seminar simulation works (1/3) and final presentation (2/3).
Remark:	**Literature:** Kondipudi, Prigogine : Modern Thermodynamics, Wiley&Son, 1998 Baumann : Symmetry Analysis of Differential Equations, Springer Verlag, 2000 Ljung, Glad : Modelling of Technical Systems, Prentice Hall, 1995 Wellsted: Introduction to Physical Modeling, Control Systems Principles, 2000
Professor:	TATARINOV Dimitri

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

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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

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Semester 2

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:

Garrison, R., E. Noreen, and P. Brewer. Managerial Accounting, 2nd Edition New York: McGraw-Hill/Irwin

with Connect Account: ISBN-13 9780071221085

Indicative Reading:

Illustrative texts and articles include:

· A Bhimani, Strategic Finance, Strategy Press, (2008)
· 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
· Miller & O'Leary, Managing operational flexibility in investment decisions: the case of Intel, Journal of Applied Corporate Finance (2005), pp. 87-93.
· Hall, M. (2008). The effect of comprehensive performance measurement systems on role clarity, psychological empowerment and managerial performance. Accounting, Organizations and Society, 33(2-3), 141-163.

Professor: LOPATTA Kerstin

Programming for engineers

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) 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)

Language: Anglais

Mandatory: Oui

Evaluation:	Written or oral exam.
Remark:	"Python for Everybody"; "Python for Informatics"; both by Charles Severance
Professor:	MINOUFEKR Meysam

Digital Factory Planning

Module:	Digital Factory Planning (Semester 2)
ECTS:	3
Teaching modality:	1 week of workshop
Language:	Anglais
Mandatory:	Oui
Evaluation:	Mandatory attendance to the workshop - assessment at the end of the workshop

Robotics

Module:	Robotics (Semester 2)
ECTS:	4
Teaching modality:	Workshop 1 week
Language:	Anglais
Mandatory:	Oui
Professor:	KUMAR Atal Anil

Laser Technology for Manufacturing

Module:	Laser Technology for Manufacturing (Semester 2)
ECTS:	4
Course learning outcomes:	You assess which laser types are suitable for which applications. You can implement concepts for new laser applications. You can list the main types of lasers. You can explain the basic terms of laser physics. You can assess the potential of laser radiation based on the process parameters. You can describe areas of industrial application of lasers
Description:	• Introduction, basics of laser, definition, laser market, laser parameters • Basic properties of laser light, light propagation, beam caustics • Laser types (gas lasers, ion lasers, solid-state lasers, fiber lasers, diodes, VCSEL) • Light and interaction with matter (absorption, impact of material, temperature)

• Beam conduction in fibers and transmissive optics, remote laser delivery
• Laser safety
• Applications of industrial machines and prototypes of hybrid laser machines
• Process technology: Laser hardening, laser welding, laser brazing
• Latest research results related to polishing, and welding of dissimilar materials

Teaching modality: Workload:

10 hours of exam preparation
30 hours of self-study and learning
20 hours of face-to-face study

Language: Anglais

Mandatory: Non

Evaluation: Written exam

Admission requirements for the exam:
- Intermediate / Preliminary examinations may be determined at the beginning of the semester. In case preliminary work has been defined, it shall be provided and assessed positively before the final exam.

Professor: PLAPPER Peter

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Semester 3

Advanced Project / Case Study

Module:	Advanced Project / Case Study (Semester 3)
ECTS:	12
Objective:	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.
Description:	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.
Language:	Anglais
Mandatory:	Oui
Evaluation:	written report+ 15 mins. presentation.+ 5 mins Q&A
Remark:	BE CAREFUL: In order to ensure broad education, we require Advanced Project / Case Study & Master Thesis being supervised by different Professors.

Operational excellence

Module:	Operational excellence (Semester 3)
ECTS:	2
Language:	Anglais
Mandatory:	Oui
Professor:	PLAPPER Peter

Integrated management systems

Module:	Integrated management systems (Semester 3)
ECTS:	3
Language:	Anglais
Mandatory:	Oui
Professor:	VON WACHTER Friedrich Karl

Scientific writing and presentation skills - MSPC

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

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Language: Anglais

Mandatory: Oui

Professor: MOLINA Angel

Artificial Intelligence

Module: Artificial Intelligence (Semester 3)

ECTS: 5

Objective: Acquire general knowledge on the objectives and application domains of Artificial Intelligence, the underlying principles behind learning models, decision systems, and problem solving tools.
Understand the purpose and role of Artificial Intelligence in real life today.
Compare and contrast various Artificial Intelligence tools and techniques, ranging from search algorithms to deep learning.
Choose the right tool to solve a given task.
Evaluate the performance of the applied algorithms and the constructed models based on reliable measures and metrics.

Course learning outcomes: After attending this class the students can describe and explain the principles behind the main Artificial Intelligence techniques, tools, models and algorithms. The students understand the hypotheses and assumptions behind each technique and can reasonably predict the consequences of these assumptions. The students are capable of choosing the right tool for the job to solve a given problem.
Having chosen the optimal Artificial Intelligence technique, the students can use it to the model the problem efficiently. The students can then implement the model using their preferred programming language, tool, or software.
The students can prepare and pre-process the data related to the problem. The students can identify existing biases and know how to avoid and/or remove them. The students can act correctly to handle missing and/or corrupted data. The students understand the importance of data, and of correct and efficient data gathering techniques.
The students can correctly evaluate the performance of the model using several metrics depending on the task and problem. The students can compare the performance to that of other models. The students can verify if their underlying assumptions are correct. The students are capable of reviewing the effectiveness of the chosen technique and identifying potential improvements.
The students can present the chosen solution, the obtained model, the performance evaluation, and the identified improvements in a precise and concise fashion.

Description: The course includes the following topics:
1.General introduction to Aritificial Intelligence
2.Problem resolution, search algorithms,
3.Games, alpha-beta pruning
4.Meta-heuristics, genetic algorithms, swarm algorithms
5.Constraint programming
6.Markov Decision Processes, reinforcement learning
7.Learning models for regression, classification, clustering
8.Evaluating the performance of a learning model
9.Decision trees, forests

	10.Artificial neural networks 11.Unsupervised learning, k-Nearest neighbours, self-organising maps, growing neural gas
Teaching modality:	Lectures, TD & TP
Language:	Anglais
Mandatory:	Non
Evaluation:	Written Examination – 70% of total mark Group Project – 30% of total mark
Remark:	Literature: Script, recommended literature in library of UL, exercises, TD, lab sessions Bishop, C. M. (2006). Pattern recognition and machine learning. springer. Mitchell, T. M. (1997). Machine learning. 1997. McGraw Hill Russell, S. J., & Norvig, P. (2016). Artificial intelligence: a modern approach. Pearson Education Limited.
Professor:	GIOVANNINI Francesco

Electrical Energy Production Transportation and Distribution

Module:	Electrical Energy Production Transportation and Distribution (Semester 3)
ECTS:	3
Language:	Français
Mandatory:	Non
Professor:	HADJI-MINAGLOU Jean-Régis

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.
Course learning outcomes:	Understanding of overall iron making procedure
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

Teaching modality: Course project and assignments

Language: Anglais

Mandatory: Non

Evaluation: Take-home assignment: 5%

Written exam: 75%

Group work: 20 %

Remark: The students need to accomplish a project. The project presentation and final report would be considered for the assessment. There are also assignment, which should be submitted in written form.

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Semester 4

Master thesis

Module:	Master thesis (Semester 4)
ECTS:	30
Language:	Anglais
Mandatory:	Oui
Remark:	BE CAREFUL: In order to ensure broad education, we require Advanced Project / Case Study & Master Thesis being supervised by different Professors.