Master of Science in Engineering - Sustainable Product Creation

Semester 1

	Vorlesung (UE)	Übung (UE)	ECTS
1.1 COMMON CORE			19
Project management	58		4
Programming for engineers (Matlab & Python)	43		4
Supply chain & logistics	45		4
Life Cycle Assessment and Eco Design	44		3
Assembly and testing technologies	44		4
1.2 MECHANICS			11
Assessment of Finite Element Calculations (Optional)	28		3
CAD & CAE (Optional)	56		4
Machine design (Optional)	24		4
1.3 ELECTRICAL AND COMPUTER ENGINEERING (ECE)			13
Sensors & signal processing (Optional)	30		3
Communication Theory (Optional)	30		3
Technical Energy Systems Modeling and Simulation (Optional)	22	22	4
Networking (Optional)	30		3

Semester 2

	Vorlesung (UE)	Übung (UE)	ECTS
2.1 COMMON CORE			14
Product Planning & Marketing for Engineers	45		3
Managerial Accounting	36		3

Master of Science in Engineering - Sustainable Product Creation

	Vorlesung (UE)	Übung (UE)	ECTS
Robotics	0		4
Programming for engineers (Optional)	48		4
2.2 MECHANICS			17
Laser Technology for Manufacturing (Optional)	32		4
Digital Factory Planning (Optional)	48		3
Advanced engineering materials (Optional)	44		4
Machine Design Exercise (Optional)	26		3
Advanced Control (Optional)	26		3
2.3 ELECTRICAL AND COMPUTER ENGINEERING (ECE)			15
Networked Feedback Systems	30	14	5
Quality of Service in Computer Networks (Optional)	45		5
Information Theory and Coding (Optional)	45		5

Semester 3

	Vorlesung (UE)	Übung (UE)	ECTS
3.1 COMMON CORE			20
Operational excellence	28		2
Integrated management systems	44		3
Scientific writing and presentation skills	45		3
Advanced Project / Case Study		300	12
3.2 MECHANICS			9
Sensors & signal processing (Optional)	30		3
Electrical Energy Production Transportation and Distribution (Optional)	26		3

Master of Science in Engineering - Sustainable Product Creation

	Vorlesung (UE)	Übung (UE)	ECTS
Energetics of the blast furnace (Optional)	30		3
3.3 ELECTRICAL AND COMPUTER ENGINEERING (ECE)			9
Artificial Intelligence (Optional)	24	24	5
Estimation approaches in advanced engineering systems (Optional)	42		4

Semester 4

	Vorlesung (UE)	Übung (UE)	ECTS
Master thesis			30
Master thesis		600	30

Semester 1

Project management

Modul:	1.1 COMMON CORE (Semester 1)
ECTS:	4
Objektiv:	Being able to organize projects and the related activities to set up a PM team.
Course learning outcomes:	Getting familiar with the basics of project management.
Beschreibung:	History of PM, Basic definitions, PM Processes, Time scheduling, Human factor in PM, establishing team work, leadership and conflict solving.
Modalitäten:	Lecture & Exercises partially in teamwork
Sprache:	Anglais
Pflichtkurs:	Oui
Evaluation:	As the learning happens during the workshop, the attendance to all the days is mandatory to be accepted to the exam. Written exam
Remark:	**Literature and Resources** Scriptum of Lecture and related exercises (will be submitted during the lecture), participation in both block lectures and integrated exercises is mandatory.
Professor:	GANTENBERG Martin Dirk

Programming for engineers (Matlab & Python)

Modul:	1.1 COMMON CORE (Semester 1)
ECTS:	4
Objektiv:	• 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.

Beschreibung:

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

Modalitäten: Lectures, Presentation, Coding using the software.

Sprache: Anglais

Pflichtkurs: 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

Supply chain & logistics

Modul:	1.1 COMMON CORE (Semester 1)
ECTS:	4
Objektiv:	At the end of the course, students are able to explain the role and the meaning of logistics and supply chain systems in modern sustainable production and logistics networks, to describe the relations between the different players and how these systems work from supplier to customers, to manage simple networks in terms of efficient and green value creation in order to maximize the overall profit in the system, to apply both basic operational and strategic methods of supply chain management.
Course learning outcomes:	Provide knowledge and insight into supply chain systems as a whole (manufacturing, distribution, retail and customer demand), understand the critical infrastructure for the production and distribution, understand 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.), apply conceptual, analytical and numerical tools for modeling and solving logistics and supply chain applications, give insight into network economics and system dynamics in supply chains.
Beschreibung:	Introduction (basic concepts and definition), Strategic fit (make-or-buy, cost, responsiveness, agility), Supply Chain integration (material flow, push/pull and lead time concept), Facility location problems, Vehicle routing problems (e.g. travel salesman problem), Supply chain network design and equilibrium, Systems dynamics and value of coordination, Transport and distribution, Forecasting, Sales and Operations Planning, Capacity and Inventory Management, Material Requirements Planning , SCM policies and performance indicators, Sustainability and Reverse logistics, Innovations in Logistics and SCM.
Modalitäten:	Lecture, group work, case studies and structured discussions.
Sprache:	Anglais
Pflichtkurs:	Oui
Evaluation:	Assessment based on written answers to a test using instructional tasks or questions (short question tests, case studies, essays), composed during 90 minutes of time on-site at the end of the term. Any language dictionary as well as a non-programmable calculator will be allowed during the exam.
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, 3rd edition, McGraw Hill, New York, 2008

•Articles from literature
•Hand-outs

Professor: KORNE Thomas Bert

Life Cycle Assessment and Eco Design

Modul: 1.1 COMMON CORE (Semester 1)

ECTS: 3

Objektiv: 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.

Beschreibung: 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

Modalitäten: Assignments, presentations and followed discussions.

Sprache: Anglais

Pflichtkurs: Oui

Evaluation: Continuous assessment

Objective of the assignments: apply theoretical knowledge (concepts, categories) from previous lectures.
Assessment criteria: quality of argumentation why concepts and categories have been applied.
Assessment rules: independent and original work, submission on time.

Remark: Literature & Resources

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

Professor: WALTERSDORFER Gregor

Assembly and testing technologies

Modul: 1.1 COMMON CORE (Semester 1)

ECTS: 4

Objektiv: Students will understand assembly technologies and related testing and adjustments in regard to the requirements of the vehicle. They can evaluate product design for assembly. Students know machinery and equipment for manual, semi-automated and automated assembly, testing and adjustment processes and are aware about the specific opportunities and limitations.

Course learning outcomes: The automotive industry is leading in advanced assembly and testing technologies.

The student will understand assembly, testing and adjustment processes at a vehicle final assembly plant and be able to apply this knowledge to future engineering tasks.

Beschreibung: Course content
1. Key performance indicators for production machines in the final assembly plant

• Tolerances and capability
• Availability
• Cycle time and volume
• Quality management

2. OOA method to work out modular concepts for production machines in the final assembly plant in regard to an efficient production of the vehicle

3. Structure of modern final assembly plants

• Principles of planning assembly plants
• Structures of assembly systems, e.g. assembly lines
• Structures of End of Line test and adjustment systems

4. Principles of assembly stations in regard to vehicle requirements

• Examples "rear axle assembly" and "marriage" stations
• Fixation technologies
• Virtual Commissioning
• Manual, semi-automatic and automatic processes
• Conveyors, manual and automatic handling devices and robotic

5. Principles of End of Line testing an adjustment stations in regard to vehicle requirements

• Basics of linear algebra and vector calculation
• Wheel alignment
• Head lamp and driver assistance systems setting
• Roll-, brake-, ABS-testing
• Manual, semi-automatic and automatic processes and adjustment devices
• Optical sensor technologies

Modalitäten: Lecture, Visit of an automotiv plant (Ford SLS, if possible)

Sprache: Anglais

Pflichtkurs: Oui

Evaluation: Written exam

Remark: Literature & Resources

Patents and Norms

Professor: TENTRUP Thomas

Assessment of Finite Element Calculations

Modul: 1.2 MECHANICS (Semester 1)

ECTS: 3

Objektiv: On completion of the course unit successful students will be able 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 (6th 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.

Course learning outcomes: When a finite element calculation has been performed and the stresses have been calculated they have to be assessed with respect to the imposed stress limits depending on the charging of the component:
· Static assessment based on linear and non-linear Finite Element Method (FEM)
· Fatigue assessment based on linear stress and strain calculations

Beschreibung:

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 npl of 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 Tn and Ts values, 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)
Modalitäten:	Lectures + tutorials
Sprache:	Anglais
Pflichtkurs:	Non
Evaluation:	Written exam
Remark:	**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

Modul:	1.2 MECHANICS (Semester 1)
ECTS:	4
Objektiv:	The main objectives are: 1-Development of a professional knowledge in technical communication tools available in actual design offices. The focus will be on understanding the different methodology of numerical model creation, using full 3D parametric capabilities. 2- Validation, Dimensioning and tolerancing of parts and systems. 3- Comprehension and production of Engineering drawings for use in different Engineering specialisations.
Course learning outcomes:	The students in the defined scope of the course can: 1- professionally work with a commonly used commercial CAD and CAE software 2- validate structurally simple parts and assembly, mechanical concept 3- Generate parametric design of Products and Systems including sustainability constraints 4- Communicate technical concepts using industrial modern tools, and understand the various standards and practices in the mechanical industrial field

Beschreibung:	Introduction to CAD 2- Feature modeling / advanced sketch 3- Parametric Modeling 4- structural simulation 5- Validation of parts and systems 6- Optimisation of geometry and material 7- Overall capabilities of CAE software
Modalitäten:	Lectures, Practical exercices, assignements.
Sprache:	Anglais
Pflichtkurs:	Non
Evaluation:	Final written exam
Professor:	WOLF Claude

Machine design

Modul:	1.2 MECHANICS (Semester 1)
ECTS:	4
Objektiv:	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 utilize CAE tools like ANSYS, Inventor, and Mathcad in design projects + is able to understand the concept of the machine element optimization and employ this method in projects.
Course learning outcomes:	The aim of the course are: + 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.
Beschreibung:	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

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 optimization

Modalitäten: Case study and lecture

Sprache: Anglais

Pflichtkurs: Non

Evaluation: Task 1 (50%):

The three assignments are graded as follows: reporting-50%, correctness of calculations and working drawing -50%.
Task 2 (50%):
The written exam consists of 3 problems to solve; each problem will be assessed, taking into account a used methodology - 60%, and numerical correctness of the solution - 40%.

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

Sensors & signal processing

Modul: 1.3 ELECTRICAL AND COMPUTER ENGINEERING (ECE) (Semester 1)

ECTS: 3

Objektiv: Gain a basic understanding of sensor and signal processing concepts.

Course learning outcomes: Understand the basic metrology, sensor concepts and signal processing methods in the context of engineering.

Master of Science in Engineering - Sustainable Product Creation

Beschreibung: Basic SI units, electrical circuits, linear time-invariant systems, Fourier analysis, analog and digital sensor data acquisition, introduction to fundamental sensor types.

Modalitäten: Lectures on course contents including sensor concepts and signal processing methods.

Examples and solutions for the topics taught in the-lecture.

Sprache: Anglais

Pflichtkurs: Non

Evaluation: **Continuous assessment**

Task 1 / Active participation (10%)

- Objectives> Encouraging students in class activities in order to improve their thinking skills and introduce new concepts to their peers.
- Assessment criteria > Student performance and participation in the classroom

Task 2 / Take-home assignment (30%)

- Objectives > Examination of students' skills and understanding of the material taught in class.
- Assessment rules > The assignments must be submitted by the deadline.
- Assessment criteria > The evaluation depends on understanding of the subject and the concept, the final results, mathematical approach, etc.

Task 3 / Written exam (50%)

- Objectives > Test the knowledge, skills, and aptitude acquired by the students.
- Assessment rules > In-class test of various types of questions, 1.5-hour duration.
- Assessment criteria > The final answers and mathematical approach.

Task 4 / Quizzes (10%)

- Objectives > Test students' level of understanding regarding the course material with providing insights into student progress.
- Assessment rules > short questions need to be solved in the classroom. Each quiz is 10 minutes.
- Assessment criteria >The final answers and the mathematical methodology of solving the problems.

Task 5 / Attendance

- Objectives > Attending lectures and exams.
- Assessment rules > It is expected to attend at least 80% of the scheduled class hours.

Remark: **Literature & resources**

Lecture slides
Own written notes from lectures
Optional:
1. Jacob Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications, Springer 2010, ISBN: 978-1441964656

2. Martin Molitor et al., Messtechnik Die ingenieurmäßigen Grundlagen, Shaker Verlag, Aachen 2009, ISBN: 978-3832286071

Communication Theory

Modul:	1.3 ELECTRICAL AND COMPUTER ENGINEERING (ECE) (Semester 1)
ECTS:	3
Objektiv:	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
Beschreibung:	* Signals and Systems * Convolution * Sampling * Stochastic Signals and Noise * Modulation and Demodulation * The Maximum Likelihood Principle * Sources and Channels
Modalitäten:	* Review of Stochastic Signals and Systems * Digital Transmission and Modulation * Demodulation * Channel Models * ML Principle * Matched Filter * Equalization
Sprache:	Anglais
Pflichtkurs:	Non
Evaluation:	Final Exam (100%)
Professor:	SORGER Ulrich

Technical Energy Systems Modeling and Simulation

Modul:	1.3 ELECTRICAL AND COMPUTER ENGINEERING (ECE) (Semester 1)
ECTS:	4
Objektiv:	Knowledge of how to model and simulate dynamic system. * 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
Course learning outcomes:	Learning how to apply simulation methods on given practical problems, having different types of technical dynamic (energy) systems.

In the seminar, techniques for modeling of technical systems are elaborated in case studies for typical technical systems employing symbolic and numeric computation methods.

Beschreibung: Theoretical basis lecture, hands on workshops with Matlab.

1 Technical Systems

2 System Structures and Model Descriptions

3 Continuous Models from Variational Analysis

4 Model Simplification

5 Optimal System Operation

Modalitäten: Read, Follow and Discuss basic lectures, hands on work with Matlab

Sprache: Anglais

Pflichtkurs: Non

Evaluation: Assessments will be given on weekly bases in first 6 week, after that self-study and autonomous working on single or group projects.

Final grade is composed of seminar simulation works (30%) and oral final presentation (70%).

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

Networking

Modul: 1.3 ELECTRICAL AND COMPUTER ENGINEERING (ECE) (Semester 1)

ECTS: 3

Objektiv: 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.

Beschreibung:
* 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

Master of Science in Engineering - Sustainable Product Creation

Modalitäten:	The course consists of a series of lectures with dedicated time slots for exercises
Sprache:	Anglais
Pflichtkurs:	Non
Evaluation:	1. Submission of exercise solutions and active participation in the exercise discussion events will count 20% of the final mark. 2. Results of the Moodle quizzes will count 20% of the final mark. 3. The final (written) exam at the end of the semester will count 60% of the final mark.
Professor:	ENGEL Thomas

Master of Science in Engineering - Sustainable Product Creation

Semester 2

Product Planning & Marketing for Engineers

Modul:	2.1 COMMON CORE (Semester 2)
ECTS:	3
Objektiv:	The objective of the course is to enable engineering students to integrate a market-oriented perspective into their thinking, (product-) designing, and decision-making.
Course learning outcomes:	After successfully completing this module, students will be able: - to evaluate (new) products and service offers in terms of customer value and potential market positioning; - to apply relevant marketing strategies to a given company and/or business unit; - to analyse determinants of buying behaviour and transfer this knowledge into applicable market segment strategies; - to integrate the customer perspective into the product development process; - to evaluate basic pricing and communication strategies in line with product positioning.
Beschreibung:	• Basic concepts of marketing • Marketing strategies • Determinants of Buying Behavior • Market Segmentation • Product/Brand Strategies • Product development and positioning • Pricing- and Communication Strategies
Modalitäten:	In class-discussions and -applications, cases, Mini-Workshops.
Sprache:	Anglais
Pflichtkurs:	Oui
Evaluation:	Written or oral exam (70%) Active participation (10%) Case study solution (20%)
Remark:	Literature & resources • Homburg, Ch., Küster, S., Krohmer, H. (latest edition): Marketing Management: A Contemporary Perspective, McGraw Hill • Kotler, P., Armstrong, G. (latest ed.): Principles of Marketing, Prentice Hall
Professor:	KÖNIG Tatjana

Managerial Accounting

Modul: 2.1 COMMON CORE (Semester 2)

ECTS: 3

Objektiv: 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.

Modalitäten: 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.

Sprache: Anglais

Pflichtkurs: Oui

Master of Science in Engineering - Sustainable Product Creation

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

Robotics

Modul: 2.1 COMMON CORE (Semester 2)
ECTS: 4
Modalitäten: Workshop 1 week
Sprache: Anglais
Pflichtkurs: Oui
Professor: KUMAR Atal Anil

Programming for engineers

Modul: 2.1 COMMON CORE (Semester 2)
ECTS: 4
Objektiv: 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.

Beschreibung:

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)

Sprache: Anglais

Pflichtkurs: Non

Evaluation: Written or oral exam.

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

Professor: CHIHI Ines

Laser Technology for Manufacturing

Modul: 2.2 MECHANICS (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

Beschreibung:
• 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

Modalitäten: Workload:

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

Sprache: Anglais

Pflichtkurs: 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, AMNE ELAHI Mahdi

Digital Factory Planning

Modul: 2.2 MECHANICS (Semester 2)

ECTS: 3

Modalitäten: 1 week of workshop

Sprache: Anglais

Pflichtkurs: Non

Evaluation: Mandatory attendance to the workshop - assessment at the end of the workshop

Professor: PLAPPER Peter, KOLLA Sri Sudha Vijay Keshav

Advanced engineering materials

Modul: 2.2 MECHANICS (Semester 2)

ECTS: 4

Objektiv: Knowledge of structural materials (metals as ferrous and nonferrous alloys; ceramics and glasses;polymers, and composites) and their use in the view of a sustainable use of resources.

Course learning outcomes: The students will be capable to understand the different properties of the different key engineering materials and their use.

Master of Science in Engineering - Sustainable Product Creation

Beschreibung:

Crystallography

Diffusion

Phase Diagrams

Metals:

- Ferrous alloys (carbon and low-alloy steels, high-alloy steels, cast irons)
- Nonferrous alloys (aluminium alloys, magnesium alloys and other alloys)
- Processing of metals and the influence on their properties
- Glasses
- Processing of ceramics and glasses and the influence on their properties

Polymers:

- Thermoplastic polymers
- Thermosetting polymers
- Processing of polymers

Powder Metallurgy:

- Cemented Carbide
- Cermets
- Compaction
- Sintering

Mechanical and Physical Properties
Materials and our environment:

- Environmental aspects of design
- Recycling

Modalitäten: Lectures

Sprache: Anglais

Pflichtkurs: Non

Evaluation: Written Exam 1: Intermediate exam for 25% of the total grade

Written exam 2: Final exam for 75% of the total grade

Remark: **Literature & resources**

Materials selection in Mechanical Design, M. F. Ashby, Butterworth-Heinemann, Burlington, 3rd ed., 2006

Engineering Materials 1 & 2, M. F. Ashby, D. R. H. Jones, 3rd ed., Butterworth-Heinemann, Burlington, 2005.

Materials Science for Engineers, J. F. Shackelford, 6th ed., Prentice Hall New Jersey, 2005.

The Science and Engineering of Materials, D. R. Askeland, 3rd ed.,Nelson Thormes Ltd., 1998.

Werkstofftechnik 1 und 2, W. Bergmann, 4. Auflage, Hanser-Verlag München, 2002.

Werkstoffe, E. Hornbogen, 7. Auflage, Springer-Verlag Berlin, 2002.

Moderne Werkstoffe, R. Gadow, A. Killinger, Expert-Verlag, 2000.

Professor: USELDINGER Ralph

Machine Design Exercise

Modul: 2.2 MECHANICS (Semester 2)

ECTS: 3

Objektiv: The goal of this course is to develop the skills of students to design machine elements using gained knowledge from completed courses (Machine Design, CAD, FEA and others) and to employ this knowledge effectively in a real design project. The course focuses on engineering analyses: analytical calculations of the strength of materials, FEA calculations, 3D design tools and finally, good project reporting.

Course learning outcomes: Upon completion of the course, the student:
+ is able to work in a group and knows his place and task. They can communicate with other members and a project supervisor and accept responsibility.
+ they can use methods of project management.
+ can carry out a technical object's design process and meet deadlines.
+ uses in practice computer-aided tools like ANSYS, Autodesk Inventor and Fusion 360.
+ solves real technical problems using previously acquired knowledge of subjects: mechanics, the strength of materials, machine element design, CAD.
+ is able to propose an appropriate technological process of manufacture and assembly.

Beschreibung: The project topic is the design and analysis of a small mechanical assembly like a clutch, a torque limiter or a gear train.
The steps of the project are shown below:
+ Creative formulating and discovering technical problems.
+ Finding solutions and analyses of issues.
+ A selection of an optimum concept and its innovation.
+ An accomplishment of strength calculations and technical documentation using computer-aided systems.
+ Consideration of manufacturability design aspects.
+ Verification of an adopted design solution to reach the prototype stage.
+ Create a final report of the project ready for a public presentation.

Modalitäten: Case study

Sprache: Anglais

Pflichtkurs: Non

Evaluation: **Take-home assignment (100%)**

The completed project will be evaluated by taking into account: the quality of the report, the correctness of strength calculations, self-reliance during the project, proactivity, and how to solve engineering problems in the project.

Master of Science in Engineering - Sustainable Product Creation

Remark: **Literature & resources**

"Fundamentals of Machine Elements, Third Edition", Steven R. Schmid, Bernard J. Hamrock, Bo. O. Jacobson
Course materials available on Moodle
Inventor Nastran, Autodesk manuals
ANSYS Workbench training materials
ANSYS manuals
Supplementary:
"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

Advanced Control

Modul: 2.2 MECHANICS (Semester 2)

ECTS: 3

Objektiv: In the creation of sustainable products, control engineering plays a more and more important role. In order to realize increasingly complex functionalities and so called "smart" products, control systems with advanced information processing capabilities have to be embedded in the product.

As an introduction, methods to model technical products and processes as sets of linear or nonlinear differential equations forming transfer function models are considered. Based on this, basic and more advanced methods to develop control systems are derived and discussed using engineering examples. Furthermore, an introduction to system-identification methods and a digital control design will be given.

- Finally, it will be discussed how basic and advanced control approaches could be simulated and tested using MATLAB software.

Course learning outcomes: 1. The students should have a profound knowledge how to model technical products and processes as continuous, discrete-event or hybrid dynamic systems.

2. Draws bode diagram for any system and design a compensate controllers (lead, lag) via frequency response using MATLAB.

3. The students are able to design, implement and test basic and more advanced control systems based on the derived system-identification models.

Beschreibung: 1. Introduction to dynamic system modelling

- basic principles
- transfer function model
- stability, transient response, and steady state error.

2. Basic linear control systems

- short repetition of basic linear SISO control
- bode diagram and frequency response analysis

3. Advanced linear control systems

- feedback control system design via frequency response.
- digital control system design

4. Introduction to system identification

- system identification theory
- data-driven control design.

5. Simulation, Testing and Implementation of Control Systems

- simulation and testing of dynamic and closed loop feedback systems using MATLAB software.

Modalitäten: Content focus and Interaction, reflection and problem solving (different exercises will be solved during each lecture).

Sprache: Anglais

Pflichtkurs: Non

Evaluation: **Written examination (80%)**

A written exam, including different exercises, will be done at the end of all lectures.

2 assignments will be given before the final exam (20%)

Take-home assignments with fixed deadlines will be given to the students to test their understanding of the lectures and to estimate their analysis capacities and how far they can look for additional information not provided in the lecture

Remark: 1.Nise, Norman S. Control Systems Engineering. John Wiley & Sons, Sixth Edition,
2.Richard C. Dorf, and Robert H. Bishop (2008). Modern Control Systems, Eleventh Edition, Prentice-Hall, Inc.
3.Arun K. Tangirala. Principles of System Identification Theory and Practice. (Chapter: 1-3; 12-15)
4.Lennart Ljung, System Identification: Theory for the User. Second edition.

Professor: ABUABIAH Mohammad

Networked Feedback Systems

Modul: 2.3 ELECTRICAL AND COMPUTER ENGINEERING (ECE) (Semester 2)

ECTS: 5

Objektiv: The objective of this course is to introduce students to networked feedback structures in interconnected information and communication technology in technical environments.

Course learning outcomes: * Identify feedback structures, decompose them and formulate continuous and sequential dynamics

* Determine reliable discrete or continuous enclosures for structure-variations and uncertainties

* Design controls with guaranteed dynamic tolerances

* Design reliable automata in technical context.

Beschreibung: Networked feedback and feedforward- sampling, scheduling and communication- continuous system representations- dynamics and approximations- systems over the binary field- binary transfer function and stability- combined systems and decompositions- feedback design in multiloop structures.

Modalitäten: Lectures & TD (tutorials)

Sprache: Anglais

Pflichtkurs: Oui

Evaluation: The grade for the course compiles 30% classwork (assignments and taking part in the lecture, attendance) and 70% exam (paper/report + presentation).

Professor: TATARINOV Dimitri

Quality of Service in Computer Networks

Modul: 2.3 ELECTRICAL AND COMPUTER ENGINEERING (ECE) (Semester 2)

ECTS: 5

Objektiv: The objective of this course is to introduce quantitative measures for network performance (like throughput, error correction, delays, routing) for different network topologies to
be applied to security protocols. It also sensibilises for differences between static and dynamic networks as well as centralised and de-centralised topologies concerning reliability and trust issues

Course learning outcomes:
* Describe performance metrics and list parameters of dedicated networks and protocols.
* Name and reproduce definitions of relevant parameters that theoretically characterise the communication traffic incl. queues, routing and error probabilities
* Analyze existing solutions according to their capabilities for throughput, error rate and security
* Construct and adapt real world communication architectures and protocols with given Quality of Service requirements on the basis of the theoretical concepts

Beschreibung:
1. Intro
2. Recap: Random Processes
3. Recap: Homogeneous Markov Chains
4. Commutation Systems: Components and modules
5. Communication Traffic as Random Process
6. Routing and Flow Control
7. Introduction to Queueing Theory
8. QoS in TCP/IP

Modalitäten: The course is organised as a series of lectures with dedicated time slots for exercises

Sprache: Anglais

Pflichtkurs:	Non
Evaluation:	70% Final Exam 30% Successful preparation, submission and active participation in exercise sessions
Professor:	ENGEL Thomas

Information Theory and Coding

Modul:	2.3 ELECTRICAL AND COMPUTER ENGINEERING (ECE) (Semester 2)
ECTS:	5
Objektiv:	The objective of this course is to provide an understanding of fundamental communication limits and means of approaching them
Course learning outcomes:	* Compute fundamental communication limits * Compress simple information sources * Describe the fundamental blocks of digital communication systems (physical layer) * Encode binary information with a convolutional code
Beschreibung:	The course contains: - Shannon's concept of mathematically quantising information and uncertainty for a communication setup - Explanations that both compression and error free transmission have an extremal rate which can be computed via entropy and mutual information - Methods to compress sources - Digital transmission techniques and their complexity for inter-symbol-interference channels - Simple error correction codes, convolutional codes
Modalitäten:	The course is organized as a series of theoretical lectures intermixed with exercises/ homework.
Sprache:	Anglais
Pflichtkurs:	Non
Evaluation:	Final Exam: 75% Homework: 25%
Professor:	SORGER Ulrich

Semester 3

Operational excellence

Modul:	3.1 COMMON CORE (Semester 3)
ECTS:	2
Objektiv:	The student can explain **lean management methods**and relates the impact of lean tools to sustainability. He / she is able to contribute improving value adding operations by analysing current processes, and evaluate them by applying lean thinking. Based on the comprehensionof the lean tools, the student demonstrates their capability to optimize production flow of an assembly plant in a simulated work environment: They evaluate the implemented standards of the simulated work environment, recommendopportunities for improvement, plan actions to enhance operational excellence and implement these activities.
Course learning outcomes:	Understand the lean and Operational Excellence philosophy. Apply learnings by working on a lean assembly line and perform Kaizen activity
Beschreibung:	1. Understand TPS / Toyota Productions system, Operational Excellence and lean philosophy. 2. Learn 7 types of waste 3. Standardization of processes as the basis of Operational Excellence 4. Continuous improvement as ongoing contribution to sustain efficient operations 5. People involvement enable collecting best ideas 6. Integrated quality saves resources 7. Short Lead time and impact of lean supply chain 8. Value Stream Management In a second part of the course the student will apply the learning in the lean management laboratory. They will assembly products, perform Kaizen workshop to involve everyone´s ideas to improve throughput.
Modalitäten:	Theoretical lectures + practical exercises
Sprache:	Anglais
Pflichtkurs:	Oui
Evaluation:	The assessment for the course Operational Excellence is in the form of assignments and quizzes. • Assignment 1 (3 points) • Quiz 1 (5 points) • Assignment 2 (4 points) • Quiz 2 (3 points) • Assignment 3 (5 points)

Remark: **Literature**

Script with all graphics which are discussed during the classes. Amended with explanatory text. Exercises enable deepening of learning content.

Integrated management systems

Modul: 3.1 COMMON CORE (Semester 3)
ECTS: 3
Sprache: Anglais
Pflichtkurs: Oui
Professor: VON WACHTER Friedrich Karl

Scientific writing and presentation skills

Modul: 3.1 COMMON CORE (Semester 3)
ECTS: 3
Objektiv: At the end of the course the student should be able to articulate ideas in a clear, coherent, and concise scientific thesis/ manuscript. The student will also be equipped with the following skills:
• How to structure a scientific thesis/ manuscript
• How to improve the existing content
• How to write a compelling abstract
• How to define problem statement and hypothesis
• How to do a literature survey
• How to use tools to cite properly
• How to choose a scientific methodology
• How to use document preparation tools such as LATEX
• How to present research results in a good way

Course learning outcomes: The course aims to provide students the background and the theoretical knowledge of elements of scientific writing. The students will learn methods and tools to improve their scientific content as well as the required skills to present scientific outcomes in a good way. The course also provides sufficient knowledge of how to structure a scientific thesis and scientific manuscript. The course intended to present different scientific methodologies and how to use a methodology for thesis/ manuscript. Verbal and non-verbal communication skills are the key objectives of this course.

Beschreibung: Module 1 – Planning for Scientific writing
Module 2 – Elements of Scientific Paper
Module 3 – Presentation skills

Modalitäten: Lectures
Sprache: Anglais

Master of Science in Engineering - Sustainable Product Creation

Pflichtkurs:	Oui
Evaluation:	**Presentation (35%)** Objectives> to present a scientific topic to a mixed audience Assessment rules > 10 minutes presentation / 5 minutes deliberation Assessment criteria > Clarity, coherence, use of facts, statistics, and details, building & design of slides, tempo of the speech, extent of interest and engagement **Active participation (10%)** Active participation in the classroom activities **Take-home assignment (50%)** Submit the scientific report **Attendance** 80% attendance is expected
Remark:	**Literature and resources** The reading list and material will be given each week before the planned course.

Advanced Project / Case Study

Modul:	3.1 COMMON CORE (Semester 3)
ECTS:	12
Objektiv:	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.
Beschreibung:	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.
Sprache:	Anglais
Pflichtkurs:	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.

Electrical Energy Production Transportation and Distribution

Modul: 3.2 MECHANICS (Semester 3)

ECTS: 3

Objektiv:

1. Knowing the different sources of energy contributing to the production of the electrical energy

2. Knowing the different solutions to network the power units together and with the consumer (smart
grid, smart metering)

3. Knowing the electrical and the mechanical conversion possibilities for the distribution of the electrical energy

4. Understanding the electrical power flow management between the power units together as well as
with the consumer

5. Knowing the electrical power quality norms

6. Knowing the power losses generation and its relative cost in the energy systems for a sustainable
and rational use of the electrical energy

Course learning outcomes:

The student will acquire a global knowledge about the production, transportation, distribution and conversion of the electrical energy, as well as its transformation into/from the mechanical energy.

The sustainable rational use of the electrical energy as well as the electrical energy management, are also covered.

Beschreibung:

1. Production of the electrical energy

• The energy sources (fossil fuels, nuclear, renewable)
• The generation of the electrical energy

2. Transportation of the electrical energy

• Electrical power transmission
• Power quality norms
• Low to high DC and AC voltage grids
• Coupling of voltage supplies

3. Conversion and distribution of the electrical energy

• Modern distribution systems
• Transformation of the electrical energy
• Smart metering, communication and control

4. Sustainable and rational use of the electrical energy

• Power losses
• Costs of the energy systems

Modalitäten: Lecture

Sprache: Anglais

Pflichtkurs: Non

Evaluation: Written Examination

Remark: Literature

[1] http://en.wikipedia.org/wiki/Electric_power

[2] James Northcote-Green, Robert Wilson, "Control and Automation of Electrical Power Distribution
Systems", Taylor & Francis 2007, ISBN 0-8247-2631-6

[3] Peter Zacharias, "Use of Electronic-Based Power Conversion for Distributed and Renewable Energy Sources", ISET 2008

[4] Adolf J. Schwab, "Elektroenergiesysteme – Erzeugung, Transport, Übertragung und Verteilung
elektrischer Energie", Springer 2008, ISBN 3-540-29664-6

[5] H.J. Haubrich, G. Henneberger, H.C. Skudelny, Müller-Hellmann, "Elektrische Energie aus regenerativen Quellen", Vorlesung der RWTH Aachen 1994

[6] Andreas Wagner, "Photovoltaik Engineering – Handbuch für Plannung, Entwicklung und Anwendung", Springer 2006, ISBN 3-540-30732-X

[7] Mark Hankins, "Stand-alone Solar Electric Systems", Earthscan 2010, ISBN 978-1-84407-713-7

[8] Michael Fette, Rolf Schwarze, Jürgen Voß, "Energieversorgung der Zukunft", VDE Verlag 1996,
ISBN 3-8007-2174-0

Professor: HADJI-MINAGLOU Jean-Régis

Energetics of the blast furnace

Modul: 3.2 MECHANICS (Semester 3)

ECTS: 3

Master of Science in Engineering - Sustainable Product Creation

Objektiv: 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

Beschreibung: 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

Modalitäten: The course includes homework and project

Sprache: Anglais

Pflichtkurs: Non

Evaluation: Take-home assignment: 5%(**Objectif:** To assess the students' knowledge of the taught course. **Assessment rules:** The answers should be relevant and reasonable: **Assessment criteria:** Calculating unknowns specified in the assignment)

Course Project: 20 % (**Objectif:** To improve students' skills in accomplishing a project from literature review to presentation and reporting on the topics relevant to the course. **Assessment rules:** To deliver the description of the state-of-the-art technology and suggesting innovative ideas how to improve them. **Assessment criteria:** A report should be submitted and a presentation should be given.)

Written exam: 75%

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.

The presentations are shared with the students

Artificial Intelligence

Modul: 3.3 ELECTRICAL AND COMPUTER ENGINEERING (ECE) (Semester 3)

Master of Science in Engineering - Sustainable Product Creation

ECTS:	5
Objektiv:	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.
Beschreibung:	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
Modalitäten:	Lectures, TD & TP
Sprache:	Anglais
Pflichtkurs:	Non
Evaluation:	**Task 1: Written Examination (70%)**

The examination will last for two hours. It will comprehensively cover all of the material discussed in the course, seminars, tutorials, and lab sessions. It will include analytical problems and descriptive questions.
Pass Criteria:
•Student exceeds expectations (excellent) = 20 – 18 points
•Student accomplished task fully as expected = 17.9 – 15 points
•Student shows basic understanding and accomplished task as expected = 14.9 – 12 points
•Students shows basic understanding and can execute the task sufficiently with some flaws = 11.9 – 10 points
Fail Criteria:
•Performance is below standard/expectations but student shows some basic knowledge = 9.9 – 8 points
•Performance is below standard/expectations, no basic knowledge of topic/procedure = 7.9 – 0 points

Task 2: Oral Presentation Resulting from a Group Project (30%)

The students will be divided into groups and will choose one project from a selection. Each project will involve studying a real-world problem and applying the Artificial Intelligence techniques discussed in class in order to solve it. The objective is to gain hands-on experience facing these problems and using these techniques, and to simulate real-world usage of Artificial Intelligence. Each group will present the results of the project in a short 5/10-minute start-up pitch-like presentation. The focus of the presentation should be on the design choices made, the assumptions and hypotheses of the solution, the parameter choice and value optimisation, the analysis of the results, the evaluation of solution performance, and the limitations and future improvements envisaged.
The projects will be assessed using peer-review: each group will evaluate two other projects, different than theirs. This is to get exposures on at least three different problems and solutions. The course coordinator will also participate in the evaluation, and the mark will be the weighted average between the groups and the coordinator. To aid with the peer-evaluation process, the students will receive an evaluation grid along with the project descriptions.

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

Estimation approaches in advanced engineering systems

Modul: 3.3 ELECTRICAL AND COMPUTER ENGINEERING (ECE) (Semester 3)

ECTS: 4

Master of Science in Engineering - Sustainable Product Creation

Objektiv:

At the end of this course the student is able to:

• Analyze and develop different types of models: white box, black box and hybrid models

• Develop internal representation and knowing its advantage compared to the external representation

• Analyze the controllability and observability of systems.

• Develop an estimator based on physical equations describing the studied system.

• Develop an estimator by signal approach

• Process and analyze the data to develop an intelligent, linear and non-linear estimators and classifiers.

Course learning outcomes:

Conventional and unconventional approaches for the control and observation of engineering systems with different applications in energy, medicine, industry, robotics, etc

Beschreibung:

1. Introduction and basics

1.1. System concept

1.2. Modelling concepts (black box, white box and gray box models, usefulness of the model for controlling and for observation)

1.3. Open loop and closed loop concepts

1.4. Measurement and observation concepts

2. State Space representation

2.1. Reminder on the Transfer Function

2.2. General principle of State Space representation

2.3. From Transfer Function to State Space representation

2.4. From State Space representation to transfer function

3. Controllability of a system

3.1. Definition of the controllability of a system

3.2. Kalman criterion of controllability

3.3. Controllability criterion applying to specific shapes (diagonal, Jordan)

3.4. System controllability study

4. Observability of a system

4.1. Definition of system observability

4.2. Kalman criterion of observability

4.3. Observability criterion applying to specific forms (diagonal, Jordan)

4.4. System observability study

5. Conventional estimation approach

5.1. Principle of observation

5.2. Condition of existence of an observer

5.3. Construction of a state observer: Luenberger observer

6. Unconventional estimation approach

6.1. Signal approach for estimation

6.2. Smart estimation approaches

6.3. General information on AI and its applications in engineering (presentation of different types of applications in control, observation, fault detection, etc.)

a. Data preparation
b. Data analysis and feature engineering
c. Linear regression
d. Nonlinear regression
e. Classification
f. Clustering

Modalitäten: Lectures

Sprache: Anglais

Pflichtkurs: Non

Evaluation: Combined assessment:

1. Project (rapport + presentation) > 30%

- Objectives: Practical application of different approaches presented in the course.
- Assessment rules: Projects carried out by 3 students. A first evaluation, report and presentation pp, to be prepared by group for the first week of November. A final report and presentation to be prepared by the end of the semester.
- Assessment criteria: Problem presentation. Presentation of the proposed solution. Relevance of the solution. Analysis and discussion of results

2. Written exam > 70%

- Objectives: General assessment of theoretical knowledge
- Assessment rules: Regular examination
- Assessment criteria: You must have a 10/20 to validate the course

Remark: **Literature**

1.IEEE Standard for a Smart Transducer Interface for Sensors and Actuators e Network Capable Application Processor (NCAP) Information Model, std. 1451.1.," IEEE, 1999.

2.E.-W. Bai and M. Deistler, "An Interactive Term Approach to Non-Parametric FIR Nonlinear System Identification," IEEE Trans. Automatic Control, vol. 55, no. 8, pp. 1952-1957, 2010.

3.Y. Avargel and I. Cohen, "Modeling and Identification of Nonlinear Systems in the Short-Time Fourier Transform Domain," IEEE Trans. Signal Processing, vol. 58, no. 1, pp. 291-304, 2010.

4.J. H. Kim and S. W. Nam, "Bias-compensated identification of quadratic Volterra system with noisy input and output," Electronics Letters, vol. 46, no. 6, 2010.

5.Y. Kibangou and G. Favier, "Identification of fifth-order Volterra systems using i.i.d. inputs," IET Signal Processing, vol. 4, no. 1, pp. 30-44, 2010.
I.J. Leontaritis and S. A. Billings, "Input-output parametric models for nonlinear systems," Int. J. Contr., vol. 41, no. 2, pp. 311-341, 1985.

6.O. A. Dahunsi, J. O. Pedro and O. T. Nyandoro, "System Identification and Neural Network Based PID Control of Servo-Hydraulic Vehicle Suspension System," SAIEE Africa Research J, vol. 101, no. 3, pp. 93-105, 2010.

7.W.-X. Zhao, H.-F. Chen and W. X. Zheng, "Recursive Identification for Nonlinear ARX Systems Based on Stochastic Approximation Algorithm," IEEE Trans. Automatic Control, vol. 55, no. 6, pp. 1287-1299, 2010.

8.K. K. Ahn and H. P. H. Anh, "Inverse Double NARX Fuzzy Modeling for System Identification," IEEE/ASME Trans. on Mechatronics, vol. 15, no. 1, pp. 136-148, 2010.

9.H.-F. Chen, "New Approach to Recursive Identification for ARMAX Systems," IEEE Trans. Automatic Control, vol. 55, no. 4, pp. 868-879, 2010.

10.I. M. Yassin, T. M. Nasir and R. Adnan, "Recent Advancements & Methodologies in System Identification: A Review, Scientific Research Journal (SCIRJ), Volume 1, Issue 1, 2013," vol. 1, no. 1, 2013.

11.E.-W. B. a. M. Deistler, "An Interactive Term Approach to Non-Parametric FIR Nonlinear System Identification," IEEE Trans. Automatic Control, pp. vol. 55(8), pp. 1952-1957, 2010.

Professor: CHIHI Ines

Master of Science in Engineering - Sustainable Product Creation

Semester 4

Master thesis

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