Fachhochschule Südwestfalen
University of Applied Sciences

Modulhandbuch für den Masterstudiengang

Systems Engineering and Engineering Management (M.Sc.)

Masterprüfungsordnung 2016

Stand Wintersemester 2022/2023

Fachbereich Elektrische Energietechnik
Standort Soest

Wir geben Impulse

Master's Project				
Code: **EEM7001**	**Workload** 0 h	**Credits ECTS / UK:** 0 / 0	**Pathway** ET / ME / MT	**Duration** 16 to 26 weeks
1	**Frequency of the course** every semester		**Contact Hours** 0 SWS / 0 h	**Self-Study** 0 h
2	**Module Outline:** The master's project enables students to apply the knowledge and skills attained in the modules of the course to a research-oriented engineering or science topic from the field of mechanical engineering, mechatronics or electrical and electronics engineering. The selected topic shall be approached considering the current state of research documented by a sound literature review. The project is supposed to demonstrate the student's capabilities to perform independent but guided research to solve practical problems with theoretical and analytical knowledge. The overall purpose of the module is to develop in the student an understanding of the steps involved in planning and conducting a research project following a systems engineering approach and in communicating the findings both orally and in writing. The attributes covered in this module are influence and impact, critical self-management, critical creativity and innovation, professional identity and skills mastery. They are able to select and apply research methods from theoretical, empirical, or conceptual directions of research. Against the background of the learnt contents and methods, students are able to critically reflect existing research and connect it with their own research questions and to consistently document and present their research process.			
3	**Indicative Content:** 1) Identification of a research topic in which staff members have experience and which is of interest to the student. Preparation of a work plan and identifying the appropriate techniques and the project structure. Undertaking a literature review to place the investigation in context. 2) Conducting the investigation and keeping a detailed record of findings. Writing up the results of the investigation in a form, this could be published. Identifying the potential utility of the research in terms of its application to social, economic or cultural needs.			
4	**Learning Outcomes:** 1) Have learned on how to examine a given problem with respect to procedures to solve it. 2) Have learned to define the major topics of problems to be solved. 3) Have learned to manage a project. 4) Have learned to write a technical paper. 5) Have learned to concentrate on major topics. 6) Have given presentations on your project, concentrated on major points.			
5	**Assessment Criteria:** Master's Project: The assessment grade of the Master's project is comprised of the following individual parts. 1. Project Plan, Seminar and Interim Report (15%) The Project Plan comprises the overall planning of the project (objectives, background, possible methods, project phases, resource planning, etc.). This must be written at the beginning of the project. The interim report is to be written after half of the project time has elapsed and the first half of the project has been completed. This report is to show the current status of the project and to assess it in comparison to the submitted plan. The project planning is then to be revised based on the interim report. During the seminar presentation, the candidate must present his/her objectives, methods, and interim results to the other master's course students and/or to his/her supervisors. 2. Implementation (10%)			

	This part of the project grade is based on the practical work of the candidate during the course of the project. The criteria for this grade are the ability to identify key aspects of the project, their ability to find a relevant methodological approach and its implementation. 3. Thesis (75%) The Master's thesis is the final and most comprehensive part of the project. The Master's thesis must comply with the standard of academic research publications. Colloquium: The content and the results of the Master's project are to be presented at the colloquium by the candidate followed by a discussion with the two examiners.	
6	**Learning and Teaching Strategy:** The module will be delivered using a blended learning approach. Students will be required to carry forward the work of the project to demonstrate initiative and self-motivation. Supervisors will provide expert support as appropriate and will recommend links with other sources of academic and industrial input. The supervisors will also give guidance on methodology, the format and content of written and oral presentations and on the submission of the final report.	
7	**Learning and Teaching Methods:**	
8	**Assessment Type:** Examination Paper ( ), Oral Exam ( ), Seminar Paper ( ), Project Assignment ( ), Combined Form of Examinations ( ), Portfolio ( ), Partial Examinations during the Semester ( ), amended by Presentation ( )	
9	**Assessment Element 1**	**Assessment Element 2**
	Weighting: 0%	**Weighting:** 0%
10	**Requirements for the Award of Credits:** Successful completion of both Master's thesis and colloquium	
11	**Relevance for the Overall Score:** According to § 23 of the Master's Examination Regulations.	
12	**Person Responsible for the Module / Instructor:** Prof. Dr. Dominik Aufderheide /	
13	**Learning Resources:**	

Systems Engineering (new: Intelligent Systems)				
Code: **EEM7010-MPO2016**	**Workload** 240 h	**Credits ECTS / UK:** 8 / 15	**Pathway** ET / ME / MT	**Duration** 1 semester
1	**Frequency of the course** winter semester		**Contact Hours** 6 SWS / 90 h	**Self-Study** 150 h
2	**Module Outline:** This module aims to introduce students to the fundamental concepts and underlying principles of systems engineering, including systems thinking, as well as the design and management of a range of engineering systems, especially including mechanical and electronic systems. The systems will be studied from a product lifecycle management perspective to cover the all stages from product market research, design, manufacturing to after-sales service and product recycles. The instruction will be supplemented with case studies and applying the knowledge in engineering simultaneously.			
3	**Indicative Content:** The module covers the area of product lifecycle management including introduction to system science and engineering, system requirement analysis and specification, system architecture design, system detail design and development, unit and system test, evaluation and validation. A special focus lies on the various ways of system modelling as a powerful tool to cover systems engineering over the product lifecycle. Furthermore, the importance of data engineering from early design phases till the end of the product lifecycle will be discussed. The module enables the students to more effectively design solutions that meet customer needs by identifying and translating them into a complete set of requirements and specifications for a system. The module emphasizes the distinction between an operational need and a system solution, and stresses the importance of understanding the customers need before jumping to a solution. The intent is not just to describe the systems engineering and architecting process but to understand the interrelation between different engineering disciplines and to stress the importance of an integrated system design. This is enabled by model and data based design techniques which enable the student to think in systems, rather than in disciplines. The module helps students understand how to think through the choices at each step of the process. What decisions have to be made? What factors should be considered in making them? The answers to these questions allow for good systems engineering without adherence to standard processes. The primary objective of this module is to achieve a strong foundation in systems engineering principles and processes.			
4	**Learning Outcomes:** 1) Be able to critically review and apply the principles of systems engineering to the practical problems of product lifecycle management. 2) Be able to develop knowledge and evaluate the system design requirements and validation. 3) Be able to understand procedures for developing physically based mathematical models of physical systems, and related analytical and numerical methods for predicting their behaviour.			
5	**Assessment Criteria:** 1) Develop confidence in using systems concepts. Understand systems engineering process models, methods and tools for the development of complex systems. 2) Explain the system development process, including requirements for systems reliability. 3) Outline and discuss the process of systems modelling, where models are used as part of a systemic approach to various systems. Derive and analyse mathematical			

	models for real world examples.	
6	**Learning and Teaching Strategy:** This module is split between formal lectures and laboratory-based practical work. Teaching will be based around handouts containing course material, and example programs. Assigned reading, tutorial and lectures will also be used to impart knowledge.	
7	**Learning and Teaching Methods:** Lectures: 60 hours Computer-based exercises: 20 hours Discussion /review /tutorial: 25 hours Coursework: 60 hours Directed reading: 25 hours Exam preparation: 50 hours Total No Hours: 240 hours	
8	**Assessment Type:** Examination Paper ( ), Oral Exam ( ), Seminar Paper ( ), Project Assignment ( ), Combined Form of Examinations (X), Portfolio ( ), Partial Examinations during the Semester ( ), amended by Presentation ( )	
9	**Assessment Element 1** E.g.: a) Analysis, design and implementation task. Assessment will be based on quality of solution, documentation and function or b): Lab exercises for modelling systems as group work, presentation and discussion	**Assessment Element 2** Examination (written, 2 hours)
	Weighting: 50%	**Weighting:** 50%
10	**Requirements for the Award of Credits:** Successfully completed Module Assessment	
11	**Relevance for the Overall Score:** According to § 23 of the Master's Examination Regulations.	
12	**Person Responsible for the Module / Instructor:** Prof. Dr.-Ing. Andreas Schwung /	
13	**Learning Resources:** - Lecture notes, South-Westphalia University of Applied Sciences - INCOSE Systems Engineering Handbook (ISBN 978-1-937076-02-3) - Systems Engineering, Principles and Practice, Kossiakoff et.al., John Wiley & Sons, 2011 - System of Systems Engineering, Mohammad Jamshidi, John Wiley & Sons, 2011	

Signal Processing

Code: EEM7011	Workload 240 h	Credits ECTS / UK: 8 / 15	Pathway ET	Duration 1 semester
1	**Frequency of the course** winter semester		**Contact Hours** 6 SWS / 90 h	**Self-Study** 150 h
2	**Module Outline:** The module is defined to impart a practical and theoretical knowledge of digital signal processing to the student. Students will learn to use and to apply techniques for designing continuous time filters as well as discrete time filters using DSP techniques. Thus, techniques for evaluation of transfer functions from both frequency domain specification and from knowledge of the continuous time prototype are introduced and developed. Techniques for evaluating the performance of discrete time systems in the time and frequency domain from knowledge of the system transfer function using both long hand and CAD techniques are developed. Techniques for designing and implementing recursive and non-recursive digital filters are taught. Fast Fourier Transform and its applications is introduced. Computer aided design packages for simulating, designing, and implementing discrete time filter architectures will be applied.			
3	**Indicative Content:** Approximation theory Transfer functions, low pass, high pass, band pass, band stop and all pass filters Analysis and simulation using PSpice Analogue system implementation - Filter network prototypes, low pass filters, frequency scaling , magnitude scaling - Network transformation, from LP to HP, BP and BS - Analysis and simulation using PSpice Sampling theory - Shannon's sampling theorem - Sub-Nyquist sampling - Signal and network aliasing Z Plane (digital) transfer function analysis - Constraints in z plane transfer functions - Recursive /non-recursive structures - Evaluation of system performance - From H(z) to the z plane transfer function using mathematical techniques - CAD tools for constraints based transfer function design Analysis and simulation using Matlab/Simulink and LabVIEW State space analysis of discrete time networks Application of state space techniques to discrete time networks Evaluation of state variables of electrical systems and of other domains Equivalence of state variables and z plane transfer function description Digital signal processing hardware - Computing architectures for signal processing - Fixed and floating point DSP processors - Reconfigurable hardware based on FPGAs - A/D resolution, coefficient word length, instruction cycle speed, bench marks - Generation of hardware specification from system requirements - Filter implementation based on a hardware design flow Recursive (IIR) discrete time structures - Design of discrete time networks based on analogue prototypes. Bilinear transformation - Impulse invariant transformation - Recursive structure overflow modes. Intermediate node distortion. Regular and			

	transposed structures. Relevance to fixed and floating point DSP hardware - High order recursive structures - Analysis, synthesis, design and simulation using Matlab/Simulink and LabVIEW Non recursive (FIR) discrete time systems FIR structure and characteristics. - Design based on inverse Fourier transforms and inverse FFT - Windows and their characteristics. Design of windows based structures - Specialist FIR structures - Integrator, Differentiator, Hilbert Transform - Use of CAD packages to design and evaluate the performance of FIR structures - Analysis, synthesis, design and simulation using Matlab/Simulink and LabVIEW FFT analysis - Theory of DFT/FFT analysis - Algorithms for FFT/inverse - FFT/based algorithms Development of measurement chains, laboratory tests - Vibration testing, modal analysis - Process monitoring in metal cutting - Acoustic emission - Noise emission - Noise cancelling in audio signals
4	**Learning Outcomes:** 1) Have knowledge and understanding of the theory of signal processing, time and frequency domain, analogue and digital signals. 2) Have knowledge and understanding of the theory of filtering signals. 3) Be able to analyse and critically assess a system to apply signal processing simulation. 4) Be able to develop measurement chains in practical application. 5) Have skills to apply data acquisition, analysis and visualisation tools to relevant application areas.
5	**Assessment Criteria:** 1) Be able to apply signal processing theory to practical situations. 2) Be able to apply to engineering scenarios and analyse performance through simulation. 3) Be able to set up different engineering application simulations and critically assess system performance to a variety of stimulations. 4) Develop a systematic approach to data acquisition for signal processing. 5) Design measurement and simulation systems for practical engineering applications.
6	**Learning and Teaching Strategy:** Structured notes will be used containing the required theory, worked examples and relevant tutorial questions. The lectures will be supported by tutorials in which the students will have to solve problems using both long hand methods and by using the supporting signal processing software and hardware platforms. These problems will be taken from variety of engineering fields e.g. communications systems, control systems, instrumentation. Laboratory and tutorial sessions are used to compare theoretical analysis/simulation to the results obtained from the experiments on the hardware and also to gain practical experience in assessing signal characteristics by evaluating their statistical description. Practical tests on how to define and set up measurement chains will be done in a laboratory. Students will have to define and set up particular task in signal processing in vibration control, modal analysis, evaluations and assessment of process data and feature extraction.
7	**Learning and Teaching Methods:** Lectures: 45 hours Computer based exercises: 15 hours Discussion / review / tutorial: 15 hours Assignment consultation: 15 hours

	Coursework: 60 hours Directed reading: 40 hours Exam preparation: 50 hours Total: 240 hours	
8	**Assessment Type:** Examination Paper ( ), Oral Exam ( ), Seminar Paper ( ), Project Assignment ( ), Combined Form of Examinations (X), Portfolio ( ), Partial Examinations during the Semester ( ), amended by Presentation ( )	
9	**Assessment Element 1** E.g.: a) Develop measurement chain to acquire sensor data. Assessment based on quality of design, analysis, function and documentation, or b) Design of filters according to a given specification, simulation, implementation and analysis	**Assessment Element 2** Examination (written, 2 hours)
	Weighting: 50%	**Weighting:** 50%
10	**Requirements for the Award of Credits:** Successfully completed Module Assessment	
11	**Relevance for the Overall Score:** According to § 23 of the Master's Examination Regulations.	
12	**Person Responsible for the Module / Instructor:** Prof. Dr.-Ing. Ulf Witkowski /	
13	**Learning Resources:** - Chi-Tsong Chen, System and Signal Analysis, Holt Rinehart and Winston, 1988 - Lynn P.A., Introduction to Analysis and Processing of Signals, MacMillan, 1982 - The Fast Fourier Transform and its Applications, Prentice Hall, 1988 - Zimmer R. et al, Signals and Systems, 3rd edition, McMillan, 1993 - Digital Signal Processing, a practical approach, Ifeachor & Jervis, Addison Wesley, 1993 - Math Works Inc., Simulink Dynamic Systems Simulation Software, 1997 - D.J. Ewings; Modal Testing, Research Studies Press, John Wiley & Sons, ISBN 0 471 90472 4. - C. Clark; LabVIEW Digital Signal Processing: and Digital Communications, McGraw-Hill, ISBN 0071444920 - N. Kehtarnavaz, S. Mahotra; Digital Signal Processing Laboratory: LabVIEW-Based FPGA Implementation, Brown Walker, ISBN 1599425505 - G. W. Johnson, R. Jenings; LabView Graphical Programming, McGraw Hill, ISBN 0 07 137001 3. - U. Tietze / Ch. Schenk: Electronic Circuits: Handbook for Design and Application, Springer	

Business in Engineering				
Code: **EEM7013**	**Workload** 210 h	**Credits ECTS / UK:** 7 / 15	**Pathway** ET / ME / MT	**Duration** 1 semester
1	**Frequency of the course** winter semester		**Contact Hours** 6 SWS / 90 h	**Self-Study** 120 h
2	**Module Outline:** There is a strong need for engineers to deal with essential elements of management, especially in developing and marketing of technologies. Theoretical understanding of this field makes interdisciplinary teamwork, planning and leading more effective. The aims of this module are to enable the student to participate in entrepreneurial management processes concerning the setting of targets, planning and marketing. This should be based on a system-theoretical understanding of the company and the ability to create and use models for analysis and solving of problems.			
3	**Indicative Content:** Introduction: understanding management. The institutional view of management. The functional view of Management: planning, organizing, controlling, leading, and deciding. The strategic and the operational level of management and their connection. Techniques and instruments of operational management. Techniques and instruments of strategic management. Analyzing strengths and weaknesses, opportunities and threats in competition. Marketing as „market-oriented management“. Marketing of technologies: the concept of „business to business“ marketing. Excursus: costs and benefits. Basic principles of „business to business“ marketing. Defining the marketing-mix: product development, pricing, communication and distribution.			
4	**Learning Outcomes:** 1) Have knowledge and understanding of management both as a function and an institution. 2) Have knowledge and understanding of basic management techniques and instruments. 3) Understand and be able to apply the benefit of management instruments in a practical environment. 4) Understand the role of markets in developing and selling of products and technologies. 5) Have knowledge and understanding of the marketing concept as „market-oriented” management. 6) Have knowledge and understanding of the principles and instruments of „business to business“-marketing. 7) Be able to solve „business to business“-marketing problems (in case studies). 8) Have knowledge and understanding of technology-selling situations.			
5	**Assessment Criteria:** 1) Discuss the focus of management within the business environment. 2) Describe management instruments and their conditions for use within business situations. 3) Practice the use of management instruments in realistic business environments as identified in case studies. 4) Be able to recognise and implement the stages of innovation in taking a product from conception to sales. 5) Compare management and marketing conceptions and apply them to typical			

	business environments. 6) Discuss and compare business-to-business and business-to-consumer marketing, and be able to select models appropriate particular business scenarios. 7) Apply business-to-business marketing to practical situations identified in case studies. 8) Assess, critically analyse, develop and present a business presentation.	
6	**Learning and Teaching Strategy:** Lectures and discussions in every topic. Case-studies to train analytic and modelling skills, especially related to the management of technologies. Role-play and case-studies to train business-to-business marketing.	
7	**Learning and Teaching Methods:** Lectures: 45 hours Discussion /review /tutorial: 30 hours Assignment consultation: 15 hours Coursework: 85 hours Directed reading: 35 hours Total No Hours: 210 hours	
8	**Assessment Type:** Examination Paper ( ), Oral Exam ( ), Seminar Paper ( ), Project Assignment ( ), Combined Form of Examinations (X), Portfolio ( ), Partial Examinations during the Semester ( ), amended by Presentation ( )	
9	**Assessment Element 1** a) Development and presentation of a business-to-business selling situation (role-play) And / or b) Essay about different asserted problems and cases	**Assessment Element 2**
	Weighting: 100%	**Weighting:** 0%
10	**Requirements for the Award of Credits:** Successfully completed Module Assessment	
11	**Relevance for the Overall Score:** According to § 23 of the Master's Examination Regulations.	
12	**Person Responsible for the Module / Instructor:** Prof. Dr. Henrik Janzen /	
13	**Learning Resources:** - Dibb, S.; Simkin, L.: The marketing casebook – cases and concepts. 2. Ed. Routledge 2001 - Hill, C.W.L.; Schilling, M.A.; Gareth, R.J.: Strategic Management – Theory and Cases: An Integrated Approach. 12. Ed., Cengage 2017 - Hutt, M.D.; Speh, T.W.: Business Marketing Management – a strategic view of industrial and organizational markets. 12. Ed., Cengage 2017 - Jobber, D.: Principles and Practice of Marketing. 9. Ed., Mc Graw-Hill 2017 - Kotler, P.: Marketing Management. 16. Ed., Prentice Hall 2022 - Kumar, S.R.: Case Studies in Marketing Mangement. Pearson India 2012 - Mead, R.: Cases and Projects in International Management. Oxford (Blackwell) 2000 - Merino, D.N.; Farr, J.V. (Edts.): The Engineering Management Handbook. American Society for Engineering Management 2010 - Mintzberg, H.; Quinn, J.B.: The Strategy Process – Concepts, Contexts, Cases. 4. Ed., Prentice-Hall 2002 - Morse, L.C.; Shell, W.L.; Babcock, D.L.: Managing Engineering and Technology – An Introduction to Management for Engineers. 7. Ed., Pearson 2020	

Technical Publications and Presentations				
Code: **EEM7014**	**Workload** 210 h	**Credits ECTS / UK:** 7 / 15	**Pathway** ET / ME / MT	**Duration** 1 semester
1	**Frequency of the course** every semester		**Contact Hours** 6 SWS / 90 h	**Self-Study** 120 h
2	**Module Outline:** Enabling the student - to plan, compose, present, and peer review scientific publications - to recognize, by logical analytical processes, subjects of scientific interest and potential - to isolate and clearly define the central problem or idea being investigated - to conduct an organized investigation of that specific topic - to proceed with a systematic search and collection of information from all accessible relevant sources, as well as, after finding and sifting out the decisive facts - and finally to organize them according to their importance for the logical development of the argument.			
3	**Indicative Content:** Preparing scientific and technical publications: Abstracts Papers Presentations: Oral presentations Peer review a peer's paper Information acquisition: Research in data-bases, library Electronic communication systems (e.g. WWW)			
4	**Learning Outcomes:** 1) Be able to prepare and peer review papers intended for scientific and technical publications. 2) Be able to supply correct references to support assertions and to acknowledge ideas and material borrowed from other sources in IEEE. 3) Be able to elucidate and discuss papers in oral presentation.			
5	**Assessment Criteria:** 1) Divide the central problem into specific problems or questions. Get thoughts down on paper in logical order. Evaluate and classify any findings according to the logical drift of the argument. Differentiate between the basic principles of different forms of communication (description, analysis, summary, paraphrase, citation, etc.). 2) Be able to construct a formal outline of a report that serves as a scientifically convincing frame for the arrangement of the collected data. Master the formal techniques and accepted standards of scientific publications. Be able to locate materials about a subject by a systematic, organized search of available sources. Be able to apply and use communication systems for information acquisition. Make use of the relevant library and internet materials. 3) Formulate in adequate English both written and verbal presentations. Prepare presentations by employing suitable layout techniques. Prepare appropriate papers and presentations by defining, stating and illustrating the scientific significance of the investigation of the material to be discussed.			
6	**Learning and Teaching Strategy:** The teaching is practice-oriented with supporting lectures in information acquisition. There is a strong emphasis on group-project work that is assessed through composition			

<table>
<tr><td></td><td colspan="2">and evaluation of topics and proposals and papers as well as oral presentation.</td></tr>
<tr><td>7</td><td colspan="2">Learning and Teaching Methods:
Lectures: 45 hours
Discussion / Review / Tutorial: 30 hours
Assignment consultation: 15 hours
Assignment preparation and completion: 2 x 40 hours
Directed reading: 40 hours
Total No Hours: 210 hours</td></tr>
<tr><td>8</td><td colspan="2">Assessment Type:
Examination Paper ( ), Oral Exam ( ), Seminar Paper ( ), Project Assignment ( ), Combined Form of Examinations (X), Portfolio ( ), Partial Examinations during the Semester ( ), amended by Presentation ( )</td></tr>
<tr><td rowspan="2">9</td><td>Assessment Element 1
Written assignment about a technical topic.
Extent: ~4000 words and oral presentation using slides or Power Point.
Duration: ~20 min.</td><td>Assessment Element 2</td></tr>
<tr><td>Weighting: 100%</td><td>Weighting: %</td></tr>
<tr><td>10</td><td colspan="2">Requirements for the Award of Credits:
Successfully completed Module Assessment</td></tr>
<tr><td>11</td><td colspan="2">Relevance for the Overall Score:
According to § 23 of the Master's Examination Regulations.</td></tr>
<tr><td>12</td><td colspan="2">Person Responsible for the Module / Instructor:
Sibylle Abbou /</td></tr>
<tr><td>13</td><td colspan="2">Learning Resources:
Reading
M. Al-Atabi, Think Like an Engineer: Use Systematic Thinking to Solve Everyday Challenges & Unlock the Inherent Values in Them. Create Space Independent Publishing Platform, 2014. ISBN 13:978-9671306307.
G. Mudhavan, Applied Minds: How Engineers Think. W.W. Norton and Co, 2015. ISBN 13:978-0393239874.
H. Petroski, Invention by Design: How Engineers get from Thought to Thing. Boston: Harvard UP, 1998. ISBN: 0674463684

Speaking & Presenting
A.S. Chilcutt and A.J. Brooks, Engineered to Speak: Helping You Create and Deliver Engaging Technical Presentations. Hoboken, NJ: Wiley-IEEE Press, 2019.
T. Nathans-Kelly and C.G. Nicometo, Slide Rules: Design, Build, and Archive Presentations in the Engineering and Technical Fields. Hoboken, NJ: Wiley-IEEE Press, 2014.
D. Sniderman, Better Technical Speaking. American Society of Mechanical Engineers. December 29, 2010.

Writing
R. Berger, A Scientific Approach to Writing for Engineers and Scientists. NY: Wiley-IEEE Press, 2014. ISBN-13: 978-1118832523
K. G. Budinski, Engineer’s Guide to Technical Writing. Materials Park, OH: ASM International, 2001.
G. Graff and K. Birkenstein, “They Say/ I Say": The Moves That Matter in Academic Writing. NY: W. W. Norton and Co., 2016.ISBN-13: 978-0393617436.
S. Heard, The Scientist’s Guide to Writing: How to Write More Easily and Effectively</td></tr>
</table>

	Throughout Your Scientific Career. Princeton, NJ: Princeton UP, 2016. D. Kmiec and B. Longo, The IEEE Guide to Writing in the Engineering and Technical Fields. NY: Wiley-IEEE Press, 2017. ISBN-13: 978-1119070139 E.B. White and W. Strunk, The Elements of Style. (any edition). Recommended Journals and Conference Proceedings • IEEE Transactions of the Professional Communication Society • Technical Communication (from the Society of Technical Communication) • Technical Communication Quarterly • ASEE Conference Proceedings (American Society of Engineering Education) • Journal of International Business Studies Topics/Research • Mc Donough, William, Cradle to Cradle- Remaking the way we make things, 2014, Vintage. ISBN-13: 978-0865475878 • Benyus, Janine, BIOMIMICRY-Innovation Inspired by Nature, 2002, William Morrow Paperbacks, ISBN-10: 9780060533229 • Baumeister et. Al., BIOMIMICRY-Resource Handbook-A seed bank of best practices, 2014, Missuola Mt, USA. ISBN-10: 1505634644 • Nachtigall/Wisser, BIONICS by Example, 2016, Springer. ISBN-10: 9783319058573 • Ikenson, Bennet, Ingenious Patents: Bubble Wrap, Barbed Wire, Bionic Eyes, and Other Pioneering Inventions, 2018, Black Dog & Leventhal. ISBN-10: 9780316438490 • Mc Donough, Baumgart, The Upcycle-Beyond Sustainability-Design for abudance, 2013, North Point Press. ISBN-10: 0865477485 • Baker Brown, D: Re-Use Atlas: A Designer's Guide Towards a Circular Ecoomy, 2017, RIBA Publishing. ISBN-10: 1859466443

Advanced Control Technology

Code: EEM7015	Workload 240 h	Credits ECTS / UK: 8 / 15	Pathway ET / ME / MT	Duration 1 semester
1	**Frequency of the course** summer semester		**Contact Hours** 6 SWS / 90 h	**Self-Study** 150 h
2	**Module Outline:** This research-oriented module enables the student to understand modern control techniques and the basic principles of Computational Intelligence with a main focus on Fuzzy Systems and Fuzzy Control. The student should be familiar with the analytical methods of modelling and design of complex, intelligent and cognitive systems for modern control and management. The goal is a mapping of the novel ideas into interdisciplinary application areas on a research-oriented level with a deeper insight into modern advanced control technology and systems theory.			
3	**Indicative Content:** The module covers the area of advanced control technology with special emphasis on the design of control systems for technical systems. To this end model based control design together with the usage of modern simulation software is applied. In detail, this module covers the following topics: Simulation Systems: Use of current software packages applying linear mathematics, using both analytical and numerical techniques, to achieve the following: Data analysis and visualisation of control systems Interactive programming, use of menu systems Understand the limitation of simulation systems Design of interactive models Simulation and model based design of control systems Advanced Control: Control oriented modeling and control of physical systems Controller design based on frequency response method State-Space approach Design of state feedback controller and state feedback observer Design of linear quadratic controller and observer Stability of linear and nonlinear dynamic systems Nonlinear System Analysis Nonlinear Controller design based on feedback linearization Model Predictive control Fuzzy Systems Fuzzy Control			
4	**Learning Outcomes:** 1) Be able to develop models of engineering systems in the field of electrical and mechanical engineering. 2) Be able to use current software simulation tools. 3) Be able to analyse nonlinear systems and design controller for them. 4) Be able to design and implement fuzzy systems.			
5	**Assessment Criteria:** 1) Constitute the differential equations of a system from its given attributes. Generate the state equations from a differential equation nth order. Generate state space system from a given system description. 2) Solve differential equations with two different and common used software tools. Design appropriate system models by means of simulation software. Describe the limits of simulation tools. 3) Understand and use basic notions of stability of nonlinear systems. Identify needs for			

	nonlinear controller design. Be able to apply nonlinear control methods to a given control problem. Compare the controller performance by means of suitable criteria. 4) Analyse the requirement and derive technical specifications for fuzzy systems. Compute fuzzy inferences and use different methods of Defuzzification. Explain the structure of Fuzzy Systems and know methods of Sugeno and Mamdani controllers.	
6	**Learning and Teaching Strategy:** This module is split between formal lectures, tutorials and computer-based practical work. Teaching is based around handouts containing course material and simulation examples of real systems. Assigned reading, tutorial and lectures will also be used to import knowledge.	
7	**Learning and Teaching Methods:** Lectures: 45 hours Computer based exercices: 15 hours Discussion / Review / Tutorial: 15 hours Assignment consultation: 15 hours Coursework: 65 hours Directed reading: 35 hours Exam preparation: 50 hours Total No Hours: 240 hours	
8	**Assessment Type:** Examination Paper ( ), Oral Exam ( ), Seminar Paper ( ), Project Assignment ( ), Combined Form of Examinations (X), Portfolio ( ), Partial Examinations during the Semester ( ), amended by Presentation ( )	
9	**Assessment Element 1** Practical work, Presentation, Coursework E.g.: a) The task is to construct the model of a given system using different software tools, and to determine differences and possibilities. or b) Usage of a software tool to depict some basics of fuzzy logic. And a manual, analytical solution of a given fuzzy set.	**Assessment Element 2** Examination (written, 2 hours)
	Weighting: 50%	**Weighting:** 50%
10	**Requirements for the Award of Credits:** Successfully completed Module Assessment	
11	**Relevance for the Overall Score:** According to § 23 of the Master's Examination Regulations.	
12	**Person Responsible for the Module / Instructor:** Prof. Dr.-Ing. Andreas Schwung /	
13	**Learning Resources:** Iserman R, Digital Control Systems, Spriner-Valeg 1991. Astrom K J, Wittenmark B, Adaptive Control, Addison-Wesley 1989. Ogata, K., Modern Control Engineering, 2010. Dorf, R., Bishop, R., Modern Control Systems, 2011. Franklin, G., Powell, D., Emami-Naeini, A., Feedback Control of Dynamic Systems, 2006. Passino,K., Yurkovich,S., Fuzzy Control, 1998. Harris C J, Billings S A, Self-tuning and Adaptive Control in Theory and Applications. IEE Control Series, Peter Peregrinus, 1988. Kosko B, Neural Networks and Fuzzy Systems, Prentice Hall, 1992. D.Driankov, H.Hellendoorn, M.Reinfrank, An Introduction to Fuzzy Control, Springer-	

	Verlag, Heidelberg, 1992. D. Dubois, H. Prade: Fuzzy Sets and Systems: Theory and Application, Academic Press, London, 1980. L.A. Zadeh et all: Theory and Applications Fuzzy Sets and Their Applications to Cognitive and Decision Processes, Academic Press, London, 1975. M.Margaliot, G. Langholz: New Approaches to Fuzzy Modeling and Control – Design and Analysis World Scientific, Singapore, 2000.

Microprocessor Based Systems

Code: EEM7016	Workload 240 h	Credits ECTS / UK: 8 / 15	Pathway ET / MT	Duration 1 semester
1	**Frequency of the course** summer semester		**Contact Hours** 6 SWS / 90 h	**Self-Study** 150 h
2	**Module Outline:** To select and use appropriate microprocessor hardware and software to solve real-time embedded system monitoring and control design problems based on state-of-the-art design methodologies following a systems engineering approach.			
3	**Indicative Content:** 1. Embedded System Design • Definition of Embedded Systems (ES) and their properties • Components and architectures of embedded systems • Cyber-physical systems and Internet-of-Things (IoT) • VDI 2206 guideline for developing mechatronic systems • Requirements Engineering for ES • V-Model development method and continuous verification • Model-based software design for embedded systems and Hardware-in-the-Loop approach • Software testing and verification procedures • Characteristics of software development for embedded systems • Project planning and time tabling, cost analysis, documentation archiving procedures • Design of a system to meet the technical requirements of a specified engineering problem 2. Embedded System Architectures • Architectures and functionality of micro processors • Arithmetic and logical operations • Instruction and register sets of microprocessors • System-on-Chip (SoC) architectures • Memory technologies • Communication interfaces • ARM architectures • Peripherals and external devices • System design procedures and modularisation • IoT platforms and cloud computing 3. Software Development for ES • Embedded operating systems • Comparison of low and high level languages • Python programming and development engines • Python libraries for ES software development • PEP-8 style • Hardware and software partitioning • Creation of re-usable library functions • Remote code execution • GPIO interfaces to hardware • User interface design and implementation • I²C interface: hardware description and software implementation • SPI interface • Cloud interface: ccloud programming and dashboarding • Performance specifications			
4	**Learning Outcomes:** 1) Have knowledge and understanding of the main concepts, interfaces and peripheral			

	components associated with microprocessor based systems. 2) Have knowledge and understanding of the development tools for microprocessor based systems and the underlying systems engineering design methodologies. 3) Have skills in design and developing of software for embedded systems in Python, have skills in testing microcontroller systems and using design tools such as Integrated Development Environments. 4) Be able to design and implement microcontroller systems for - IoT applications - Control applications - Intelligent systems	
5	**Assessment Criteria:** 1) Describe and discuss the main characteristics of microprocessor and microcontroller architectures. Describe the features and application of various peripheral modules and IO-Interfaces in typical SoC devices. 2) Evaluate, select and use appropriate design tools and methodologies for the development of microprocessor based systems. 3) Develop software to use the peripheral components of a microcontroller (IO Ports, communication interfaces, etc.) and integrate them to application programs. 4) Analyse requirements and derive a technical specification. Design and implement a system to meet the technical requirements within time and budget limits.	
6	**Learning and Teaching Strategy:** This module is split between formal lectures and laboratory-based practical work. Teaching will be based around handouts containing course material, and example programs. Assigned reading, tutorial and lectures will also be used to import knowledge.	
7	**Learning and Teaching Methods:** Lectures: 30 hours Computer-based exercises: 30 hours Discussion /review /tutorial: 15 hours Assignment consultation: 15 hours Coursework: 2 x 30 hours Directed reading: 40 hours Exam preparation: 50 hours Total: 240 hours	
8	**Assessment Type:** Examination Paper ( ), Oral Exam ( ), Seminar Paper ( ), Project Assignment ( ), Combined Form of Examinations (X), Portfolio ( ), Partial Examinations during the Semester ( ), amended by Presentation ( )	
9	**Assessment Element 1** E.g. : a) Design and implementation exercise. Assessment will be based on quality of design, documentation and function or b) Analysis, design and implementation task. Assessment will be based on quality of analysis, design, documentation and function	**Assessment Element 2** Examination (written, 2 hours)
	Weighting: 50%	**Weighting:** 50%
10	**Requirements for the Award of Credits:** Successfully completed Module Assessment	
11	**Relevance for the Overall Score:** According to § 23 of the Master's Examination Regulations.	
12	**Person Responsible for the Module / Instructor:** Prof. Dr. Dominik Aufderheide /	
13	**Learning Resources:**	

	Dominik Aufderheide: Lecture Notes for the Module “Microprocessor Based Systems”, FH SWF, 2020 Peter Marwedel: Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems, and the Internet of Things, Springer Verlag, Berlin 2021 Elecia White: Making Embedded Systems: Design Patterns for Great Software, O’Reilly and Associates, 2011 Derek Molloy: Exploring Raspberry Pi: Interfacing to the Real World with Embedded Linux, Willey, 2016 Roger Hu: Embedded Systems Architecture and Software Design: Software Design Principles, Considerations, Design Concepts, and Building Blocks, 2022 Andrew Sloss: ARM System Developer's Guide: Designing and Optimizing System Software (The Morgan Kaufmann Series in Computer Architecture and Design), Morgan Kaufmann, 2010

International Project Management

Code: EEM7017	Workload 210 h	Credits ECTS / UK: 7 / 15	Pathway ET / ME / MT	Duration 1 semester
1	**Frequency of the course** summer semester		**Contact Hours** 6 SWS / 90 h	**Self-Study** 120 h

2 Module Outline:

Just in time development of new products requires a systematic approach using the methodology of modern project management. A basic knowledge is essential for engineers from all disciplines. This module offers an introduction into international project management on various levels of the system (project – programme - portfolio).

Increasing complexity and the dynamics of change are challenges that have to be mastered by an organisation's management which has led to a high degree of specialisation and division of work. However, isolated solutions for individual problems are not efficient. The (young) engineer in his / her role as manager has to cooperate with others and has to coordinate the work within projects across functional boundaries. He / she needs background knowledge and some expertise in leading a team as well as a serious understanding about related aspects of systems engineering (e.g. requirements analysis, integration management).

Obviously, there is a strong need for engineers to deal with essential elements of management, commercial issues and inter-personnel relationship. Having – at least - heard the theoretical background of this field makes interdisciplinary teamwork, planning and leading more effective.

One of the guiding motivations is transfer: from theory to practice, between students based on their own experience as well as between the various levels of a hierarchy within an organisation. Life-long-learning is essential for the younger generation of managing engineers.

3 Indicative Content:

The module consists of 5 focus themes which are overlapping.

1. Start-Up (Case Study)
• International case study done in mixed project teams (experience the intercultural richness)
• Introduction: understanding project management
2. PM Basics (Lecture)
• Historical background
• Characteristics of a project
• Relevance of the "Magic Triangle" (cost, time, performance)
• Standards and Non-Profit-Organisations (PMI, IPMA)
• Project- and product lifecycle
• Total Cost of Ownership approach (TCO)
• Working in a multi-project environment: Project – Programme – Portfolio
• Roles and responsibilities of Client, PM, team members and steering committee
• Essentials of Stakeholder Management, including commitment of project team members
• Achieving business benefits through projects – the customer's perspective
• Generic Project management model (linked with Stage Gate Concept)
• Project-specific phase model including milestones
• Initiation of projects
• Project Charter
• Scope
• Work Breakdown Structure (WBS)
• Scheduling and resource allocation
• Forecast of sales, cash flow and break-even

	3. PM Applied (Software training) • Hands-On training at computer lab with Software MS-Project • Application of planning tools in a (smaller) case study • Understanding the interdependencies between planning elements of a project • Developing a reasonable basic project plan 4. PM Advanced (Presentations) • In-depth presentations by intercultural mixed student teams on selected advanced topics in 4 sequences: - Technical PM - Legal, Political and Financial Aspects - Projects in specific situations - Soft skills for project managers. • Developing a suitable HandOut as management summary in a given format. 5. Close-Down (Lecture) • Systematic closing of a project • Preparation for after sales service • Final project report • Evaluation of projects performance
4	**Learning Outcomes:** 1) Understand what characterises a project in terms of cost, time and performance. How these are interpreted as target outcomes of projects. 2) Have knowledge and understanding of the historical background of project management. 3) Have knowledge and understanding of what is the project manager's responsibility. 4) Understand project management as relevant interdisciplinary approach and a major management challenge. 5) Have knowledge about the difference between project, program and portfolio and understand the interconnections and priorities in a multi-project environment. 6) Have knowledge and understanding of project team members, team psychology and how to motivate the team to meet the commitments of project. 7) Have knowledge and understanding of basic project management tools and instruments. 8) Be able to use a current PM-software tool to develop a basic plan for a project. 9) Have broadened your background knowledge and understanding of advanced PM topics.
5	**Assessment Criteria:** 1) Describe the main characteristics of project management. This will set the subject in its historical context and illustrate the roles and characteristics of all those involved in project management. 2) Be able to explain and apply context-related relevant methods and tools for project selection, initiation and implementation. 3) Have gained your own experience as member of an international project team bridging the gap of language and perception. 4) Practice the use of appropriate project management tools and instruments in realistic business environments as identified in case studies. 5) Critically appraise a project and after analysis, design a project management plan using the computer program MS project. This project plan will show the work breakdown structure, introduce milestones, allocate resources and show the cost versus time as well as the load of resources. 6) Assess, critically analyse, develop and present a business presentation in the right context.
6	**Learning and Teaching Strategy:** Lectures and open discussions in every topic, intense interaction between students and teachers. This module is split between formal lectures, tutorials, SW-training in the computer lab and practical work in student teams out of university. Teaching is based on the scriptum

	which can be downloaded, containing course material and examples of real project documents. Assigned reading, tutorial, practical labs and lectures will also be used to import knowledge.	
7	**Learning and Teaching Methods:** Lectures: 45 hours Computer-based exercises: 15 hours Discussion /review /tutorial: 15 hours Assignment consultation: 15 hours Assignment preparation and completion: 40 hours Coursework: 40 hours Directed reading: 40 hours Total No. Hours: 210 hours	
8	**Assessment Type:** Examination Paper ( ), Oral Exam ( ), Seminar Paper ( ), Project Assignment ( ), Combined Form of Examinations (X), Portfolio ( ), Partial Examinations during the Semester ( ), amended by Presentation ( )	
9	**Assessment Element 1** a) Team-Presentation about an advanced topic in Project Management And / or b) Learning Logbook Written report with a very individual reflection on your own performance as adult learner; maximum 2 pages per lecture unit (total: approx. 25 pages) And / or c) Individual implementation of a Project Plan using Microsoft Project Students shall implement a detailed Project Plan using Microsoft Project as design tool. This plan shall include details regarding project structure, phases, tasks, resources, costs, and other related details; which reflect the student knowledge about project planning, using MS Project as a design tool, and optimizing the usage of project resources.	**Assessment Element 2**
	Weighting: 100%	**Weighting:** %
10	**Requirements for the Award of Credits:** Successfully completed Module Assessment	
11	**Relevance for the Overall Score:** According to § 23 of the Master's Examination Regulations.	
12	**Person Responsible for the Module / Instructor:** Prof. Dr. Florian Dörrenberg / Ahmad Abbadi	
13	**Learning Resources:** • Burke, Rory: Project Management - Planning and Control Techniques; John Wiley & Sons, England, 5th ed., 2013 • Cleveland, David L.: Project Management - Strategic Design and Implementation; McGraw-Hill, New York, 5th ed., 2006 • Dinsmore, Paul C. (Editor): The AMA Handbook of Project Management; McGraw-Hill / AMA, New York, 3rd ed., 2010 • Gray, Clifford / Larson, Erik: Project Management - the complete guide for every manager; McGraw-Hill, New York, 3rd rev. ed., 2002 • Kerzner, Harold: Project Management : A Systems Approach to Planning, Scheduling	

	and Controlling; John Wiley & Sons, New York, 10th ed., 2009 and Project Management Workbook; John Wiley & Sons,6th ed., 1998 • Lock Dennis: The Essentials of Project Management; Gower, 2014 (Paperback) • Meredith, Jack R/ Mantel, Samuel J.: Project Management - A Managerial Approach (with CD-ROM); John Wiley & Sons, New York, 8th ed., 2012 • Turner, Rodney: Gower Handbook of Project Management; Gower, 5h ed., 2014 • DIN-ISO, IPMA and PMI: Up-to-date standards in Project Management • Lecture Notes from Prof. Dr. Florian Dörrenberg

Modelling and Simulation of Mechanical Systems				
Code: **EEM7018**	**Workload** 240 h	**Credits ECTS / UK:** 8 / 15	**Pathway** ME	**Duration** 1 semester
1	**Frequency of the course** summer semester		**Contact Hours** 6 SWS / 90 h	**Self-Study** 150 h
2	**Module Outline:** The student learns that thorough modelling of mechanical components and technical systems and the subsequent numerical simulation methods, implemented in commercial CAX-software packages for simulations. A major approach will be that students can set up simple models from applying basic equations of advanced mechanics. On the system level, the student learns that building digital twins has enabled, improved, accelerated virtual CAX-product design. It will be understood that functional analysis as well as sustainable design by saving material and predicting structural failure can be achieved by modelling and simulation at no loss of economic gain. Established results in automotive, aircraft, aerospace, semiconductors, robotics, tooling machines, trains, wind mills, and others, will be outlined.			
3	**Indicative Content:** Solid Mechanics Kinematic of deformation, strain and stress tensors, material laws (thermo-elasticity, plasticity, creep, viscoelasticity, fatigue) under mechanical, thermal or chemical loading situations are treated analytically, usually taught by dimensional models. Finite Element Method (FEM) - basic approach of the approximating FE-method: weak formulation (variational principals, Galerkin method) for thermo-mechanical systems - discretization: shape functions, iso-parametric concept, element types, meshing techniques, numerical integration for elements - Application of a professional FEM-software to a small industry-like project Multi Body Simulation (MBS) - free and forced dynamics of mass-spring-damper-systems in plane cases (free body diagrams, systems of ordinary differential equation, related eigenvalue-/eigenvector problems, frequency-transfer functions) - brief introduction to spatial kinematics (degrees of freedom, rotations by Euler angles, constraints, minimal coordinates) - spatial Kinetics (Newton Euler vs Lagrange Equations Differential Algebraic Equations) - Application of a professional MBS-software to a small industry-like project Work out of integration of simulation methods into system-level product design based on application in automotive, e.g. car suspensions.			
4	**Learning Outcomes:** 1) have knowledge of the theory of solid and dynamic mechanical components 2) determine mathematical models from balance equation, material laws and kinematic 3) have knowledge and be able to solve differential equations for mathematical models 4) be able to create a computational model in a complex and professional simulation software to run the solver and performing post-processing, be able to analyse and critically assess features extracted from numerical simulation software tool 5) know on system level how and when and to what extent digital twins and numerical simulation contribute to product development			
5	**Assessment Criteria:** 1) be able to build simple classroom-level physical models and generate associated mathematical models. 2) be able to solve differential equation analytically, if available, or by known numerical procedure by treating classroom systems (solution, simulation, analysis). 3) be able to demonstrate building model feature, conducting simulations with requested			

	solver setting and on-line application of various analyses in a review session. 4) develop a systematic approach by adopting heuristic reasoning and develop test scenarios with known limits of mathematical solutions and /or experimental results. 5) be able to place and track simulation in a product development plan and schedule.	
6	**Learning and Teaching Strategy:** This module is mainly devoted to advanced expert knowlegde in modeling and simulation of mechanical systems, but importantly also trains the system level pespective of simulation. The system part will be treated at the beginning of the course and again at the end utilising advanced expert knowledge. Students will form a product planning team, using project management competencies they learned in related module courses. The timewise main part of expert knowledge is divided into formal lectures to outline the theoretical background, followed up by further assigned reading and working out small mathematical models by semselves as part of the assignment. One simple hand model shall be analyzed for characteristic features theoretically. Their behavior has to be simulated by tools like Matlab. Based on acquired experiences with small models, the students shall work out a more complex industry-like assignment problem by using the available professional simulation software, where the FEM-project or MBS-project will be prescribed by the instructor. For the assessment a report must be submitted, presented and defended. The course will close with a written examination covering the lecture contents to verify that the trained skills are solid and can be applied to unknown case.	
7	**Learning and Teaching Methods:** Lectures: 45 hours Computer-based exercises: 15 hours Discussion /review /tutorial: 15 hours Assignment consultation: 15 hours Coursework: 65 hours Directed reading: 35 hours Exam preparation: 50 hours Total No. Hours: 240 hours	
8	**Assessment Type:** Examination Paper ( ), Oral Exam ( ), Seminar Paper ( ), Project Assignment ( ), Combined Form of Examinations (X), Portfolio ( ), Partial Examinations during the Semester ( ), amended by Presentation ( )	
9	**Assessment Element 1** E.g.: a) Develop a small physical and related mathematical model (structural / dynamic), characterize formally, visualize by simulation. b) Build numerical model of a given complex, industry-level problem in professional FEM-software (Abaqus) or MBS-software (Adams), simulate, analyse, assess, recommend. Assessment based on report, presentation and defending.	**Assessment Element 2** Examination (written, 2 hours)
	Weighting: 50%	**Weighting:** 50%
10	**Requirements for the Award of Credits:** Successfully completed Module Assessment	
11	**Relevance for the Overall Score:** According to § 23 of the Master's Examination Regulations.	

12	**Person Responsible for the Module / Instructor:** Prof. Dr.-Ing. Alfons Noe /
13	**Learning Resources:** - Ascher, U. M., Petzold, L. R.: Computer Methods for Ordinary Differential Equations and Differential-Algebraic Equations, SIAM – Society of Industrial and Applied Mathematics (1998). - Baehr, H.D., Stephan, K.: Heat and Mass Transfer, Springer (2011). - Bathe, K.J.: Finite Element Procedures in Engineering Analysis. Prentice Hall (1982). - Hughes, T.J.R.: The Finite Element Method: Linear Stzatic and Dynamic Finite Element Analysis. Dover Civil and Mechanical Engineering (2000). - Kwon, Y.W., Bang, H.: The Finite Element Metod using MatLab, CRC Press (2013). - McConville, J. B.: Introduction to Mechanical System Simulation using Adams, SDC Publications (2015). - Noe., A.: Modelling and Simulations of Mechanical Systems, Lecture Notes (2022). - Nikravesh, P. E.: Planar Multbody Dynamics, CRC Press (2008). - Öchsner, A., Merkel, M.: One Dimensional Finite Element Method, Springer (2013). - Pfeffer, P.: 12th International Munich Chassis Symposium 2021, Springer (2022) - Preumont, A.: Twelve Lectures on Structural Dynamic. Springer (2013). - Schramm, D., Hiller M., Bardini, R.: Vehicle Dynamics, Springer (2014). - Stark, R.: Virtual Product Creation in Industry, Springer (2022).

Advanced Production Engineering				
Code: **EEM7019**	**Workload** 240 h	**Credits ECTS / UK:** 8 / 15	**Pathway** ME / MT	**Duration** 1 semester
1	**Frequency of the course** winter semester		**Contact Hours** 6 SWS / 90 h	**Self-Study** 150 h
2	**Module Outline:** Students will be able to leverage their knowledge and skills in management and control of the overall production system and in areas related to production system design and improvement. They will master different methods used to analyze and approach the value stream of a single production or a production network. Important is beside the technical system of production also to get a deep understanding of the organizational environment to consist of management infrastructure or culture of a company. The basic objectives are as follows: - understand modern production technologies and philosophies for mass and medium size customized series and, based on this, formulate and solve operational and strategic problems in design, operation and improvement of the manufacturing systems in a single production or production network - master modern reengineering and improvement tools in manufacturing, and methods used in analyzing performance of the production system - understand relations between customer orders and demand and the resulting shop orders, via the process of manufacturing planning and control - understand and analyze how manufacturing interplay with economic, organizational and business issues of the firm, and be able to formulate an operational manufacturing strategy like Lean production or the Toyota production system - be an expert in manufacturing process control and optimization, often with the purpose to improve production economics and efficiency with help of the value stream design or the continuous improvement process on the shop floor - be an expert in design of organizations with flat hierarchies and a leadership based on coaching principles - be an invaluable team worker/project leader as a production process expert in any situation of interdisciplinary physical product development.			
3	**Indicative Content:** - Introduction: Production or supplier network - Classic way of production planning and control - Method of value stream mapping - Best practice of Toyota Production Systems / Lean Production: Success Story of Porsche - Lean Elements – Elements of optimization a technical production system (1) - Shop Floor Management – Element of optimization of the emotional production system (2) - Learning to work and create a Kaizen Workshop to optimize the assembly flow with help of a U-Cell - Discussion the book “Journey to Lean – a change process story” - Preparing additional and special topics, presentation in small teams & following discussion			
4	**Learning Outcomes:** 1) Have a systematic understanding of modern advanced mechanical systems with manufacturing or assembly processes and production management for flexible customized series production. 2) Have understanding of industrial processes for production system environment and network. 3) Have knowledge of improvement tools and techniques in different contexts based on			

	Lean philosophy. 4) Have a comprehensive knowledge of methods, and tools to manage complexity and control of advanced production systems.	
5	**Assessment Criteria:** 1) Have communication and presentation skills appropriate to modern production systems in different branches. 2) Analyse practical situations and generate solutions to problems arising in the field, organise efficient team work by means of clear organisational structures and optimised communication within a corporate working atmosphere. 3) Be able to undertake successfully an extended project in failure and process analysis. 4) Have the skills to optimize the value stream with help of important lean elements.	
6	**Learning and Teaching Strategy:** Lectures, seminars, practical exercise, case studies, reports from external experts and visits to industrial plants. There is a strong emphasis on project work which is assessed through practical demonstration, report, writing and oral presentation.	
7	**Learning and Teaching Methods:** Lectures: 45 hours Discussion / Review / Tutorial: 30 hours Assignment consultation: 15 hours Coursework: 3 x 35 hours Directed reading: 45 hours Total No. Hours: 240 hours	
8	**Assessment Type:** Examination Paper ( ), Oral Exam ( ), Seminar Paper ( ), Project Assignment ( ), Combined Form of Examinations (X), Portfolio ( ), Partial Examinations during the Semester ( ), amended by Presentation ( )	
9	**Assessment Element 1** a) Written assignment about defined special production process topics Extent: ~2400 words Presentation of the paper and / or b) Assignment about optimization of a production system of a product family with help of value stream mapping method	**Assessment Element 2**
	Weighting: 100%	**Weighting:** 0%
10	**Requirements for the Award of Credits:** Successfully completed Module Assessment	
11	**Relevance for the Overall Score:** According to § 23 of the Master's Examination Regulations.	
12	**Person Responsible for the Module / Instructor:** Prof. Dr. Dominik Aufderheide / Dr. Pawel Rokicki	
13	**Learning Resources:** [OHN-93] Ohno, Taiichi: „Das Toyota Produktionssystem“; Campus, 1993 [WOM-07] Womack, James P.; Jones, Daniel T.: „The Machine That Changed the World: The Story of Lean Production-- Toyota's Secret Weapon in the Global Car Wars That Is Now Revolutionizing World Industry“; 2007 [ROT-99] Rother, Mike; Shook, John: “Learning to See: Value-Stream Mapping to Create Value and Eliminate Muda: Value Stream Mapping to Add Value and Eliminate Muda “, Lean Management Institut, 1999 [ROT-13] Rother, Mike; Harris, Rick: “Creating Continuous Flow: An Action Guide for Managers, Engineers and Production Associates“, Lean Management Institut, 2013 [WOM-03] Womack, James P.; Jones, Daniel T.: „Lean Thinking: Banish Waste And Create Wealth In Your Corporation“; 2003	

	[WOM-12] Womack, James P.; Jones: „Seeing the Whole Value Stream“; 2012 [BIC-09] Bicheno, John; Holweg, Matthias: “The New Lean Toolbox: The Essential Guide to Lean Transformation“, 2009 [DER-05] Drew, John; McCallum, Blair, Roggenhofer, Stefan: „Journey to Lean: Making Operational Change Stick“; 2004 [MAS-92] Masaaki Imai: „Kaizen“, 1992 [KLU-10] Klug, Florian: „Logistikmanagement in der Automobilindustrie“; Springer, 2010 [WOH-07] Wohland, Gerhard; Wiemeyer, Matthias: „Denkwerkzeuge der Höchstleister“; Murmann, 2007 [GOR-13] Gorecki, Pawel; Pautsch, Peter: „Praxisbuch Lean Management“; Hanser, 2013 [KOT-95] Kotter, John P.: „Das Unternehmen erfolgreich erneuern“; Harvard Business Manager, 1995 [KHO-11] Khodawandi, Darius: „Wettbewerbsfähige Prozesse am Beispiel der Porsche Produktionssystems sowie dessen Übertragung auf die Software-Entwicklung“; Vortrag bei Microsoft 2011 [HER-10] Herbek, Peter: „Strategische Unternehmensführung“; mi-Verlag, 2010

Integrated Management Systems (new: Systems Engineering)				
Code: **EEM7020**	**Workload** 210 h	**Credits ECTS / UK:** 7 / 15	**Pathway** ET / ME / MT	**Duration** 1 semester
1	**Frequency of the course** summer semester		**Contact Hours** 6 SWS / 90 h	**Self-Study** 120 h
2	**Module Outline:** This module aims to introduce students to the fundamental concepts and underlying principles of systems engineering, including systems thinking, as well as the design and management of a range of engineering systems, especially combining mechanical, electronical, and software systems. The systems will be studied from a product lifecycle management perspective to cover all stages from product market research, design, manufacturing to after-sales service and product recycles. The instruction will be supplemented with case studies and applying the knowledge in engineering simultaneously.			
3	**Indicative Content:** Product lifecycle management • System requirement analysis and specification • System architecture design, system detail design and development • Unit and system test, evaluation and validation Understand the interrelation between different engineering disciplines and to stress the importance of an integrated system design. Enable the student to think in systems, rather than in disciplines. Quality Management: • Perspectives on quality • Objectives of integrated quality management systems • ISO 9000 systems Environmental Management: • Objectives and motivation of environmental protection • Activities and procedures to set up an EMS • Environmental policy and review • Structure of ISO14000/14001 Innovation Management: • Solution oriented creativity techniques • Invention vs. Innovation • Innovation management : Principles, tools, and methods • Project assessment and selection • Implementation of innovation			
4	**Learning Outcomes:** 1) Understand the idea and principles of product lifecycle management. 2) Understand the nature of quality management and environmental management as holistic approaches. 3) Be able to successfully contribute to TQM-, ISO 9000-, and ISO 14000/14001 processes in organizations. 4) Understand innovation management as a process and a major management responsibility.			

5	**Assessment Criteria:** 1) Be able to make use of product lifecycle management with its tools 2) Be able to explain relevant management methods and tools for successful quality management and environmental management. 3) Be able to describe and analyse case studies in the area of quality management and environmental management. 4) Be able to explain and apply relevant methods and tools for project search, selection, implementation and capturing.	
6	**Learning and Teaching Strategy:** Lectures, seminars, practical exercises, case studies, reports from external experts and visits to industrial plants. There is a strong emphasis on project work which is assessed through practical demonstration, report, writing and oral presentation.	
7	**Learning and Teaching Methods:** Lectures: 45 hours Computer based exercises: 15 hours Discussion / Review / Tutorial: 15 hours Assignment consultation: 15 hours Coursework: 3 x 20 & 1 x 30 hours Directed reading: 30 hours Total No. Hours: 210 hours	
8	**Assessment Type:** Examination Paper ( ), Oral Exam ( ), Seminar Paper ( ), Project Assignment ( ), Combined Form of Examinations (X), Portfolio ( ), Partial Examinations during the Semester ( ), amended by Presentation ( )	
9	**Assessment Element 1** Assignment related to product lifecycle management and / or Assignment related to quality management or environmental management in an organisation and / or Assignment related to innovation management in an organisation	**Assessment Element 2** Oral examination or written test
	Weighting: 50%	**Weighting:** 50%
10	**Requirements for the Award of Credits:** Successfully completed Module Assessment	
11	**Relevance for the Overall Score:** According to § 23 of the Master's Examination Regulations.	
12	**Person Responsible for the Module / Instructor:** Prof. Dr. Andreas Wübbeke /	
13	**Learning Resources:** Haberfellner et. all. - Systems Engineering: Fundamentals and Applications, 2019. Weilkiens, Soley - Systems Engineering mit SysML/UML: Anforderungen, Analyse, Architektur, Dpunkt.verlag, 2014. Münch - System Architecture Design and Platform Development Strategies, Springer, 2022. Dahlgaard, Kristensen and Kanji – Fundamentals of Total Quality Management-Chapman & Hall, 1998, ISBN; 0412-57060. Juran and Gryna - Quality planning and analysis, Third edition, McGraw-Hill, 1993, ISBN; 0070331839. Pearatec - Total Quality Management – Chapman& Hall, 1998, ISBN 0 412-58640. Caplen – The Quality system: A sourcebook for managers and engineers, Chilton 1980. Davis - Productivity improvements through TPM – Prentice Hall – 1995, ISBN; 013	

	133034-9. O'Conner – Practical Reliability Engineering – John Wiley and Sons, 1991, ISBN: 0471926965. Lewis – Introduction to Reliability Engineering – Second Edition, John Wiley and Sons, 1996, ISBN: 0471018333. P. Crosby " Quality is free" McGraw Hill 1978. Sherwin and Bossche – The Reliability, Availability and Productiveness of Systems – Chapman and Hall, 1993, ISBN: 0412393204. O'Conner – Practical Reliability Engineering – John Wiley and Sons, 1991, ISBN: 0471926965. Lewis – Introduction to Reliability Engineering – Second Edition, John Wiley and Sons, 1996, ISBN: 0471018333. Jackson, Suzan L: The ISO 14001 Implementation Guide, John Wiley & Sons, Inc., ISBN 0-471-15360-5. Dr. John Terninko, Alla Zusman, Boris Zlotin Step-by-step TRZ: Creating Innovation solution concepts, 1997. Robert M. Verburg, J. Roland Ortt , Willemijn M. Dicke: Managing Technology and Innovation: An Introduction, December 16, 2005, ISBN-10: 0415362296. Allan Afuah: Innovation Management: Strategies, Implementation, and Profits, 2002, ISBN-10: 0195142306. TRIZ research report: An Approach To Systematic Innovation, 1998, ISBN:1879364999. Altshuller G. The Innovation Algorithm. TRIZ, Systematic Innovation and Technical Creativity. Technical Innovation Center, Inc. Worcester, MA, 1999. Altshuller G., Zlotin B., Zusman A., and Philatov V. Tools of Classical TRIZ. Ideation International Inc. 1999. G. Altshuller, Lev Shulyak, Dana Clarker Sr: '40 Principles Extended Edition: TRIZ keys to Innovation', Technical Innovation Center, Inc. April 2005. Darrell Mann: 'Hands On: Systematic Innovation', Creax ISBN:9077071024, 2002.