M.Sc. Systems Engineering and Engineering Management

Module Descriptions

Version: 12 July, 2016

1 Advanced Control Technology (ET)

1. CODE	**EEM4015**
2. TITLE	**Advanced Control Technology (ET)**
3. PATHWAY	**ET**
4. INSTRUCTOR	**Prof. Dr.-Ing. Sigrid Hafner**
5. CREDITS	**ECTS 8 (15)**

6. DESCRIPTION AND PURPOSE OF MODULE – studying this module involves the following:

Characterization of systems using state space equations; Design and optimization of state space controllers; Comparison to other methods e.g. conventional PID control with transfer functions, Analysis of control concepts using Matlab Simulink;

Nonlinear modelling with basic principles of Computational Intelligence with the two methods Neural Networks and Fuzzy Systems are discussed and compared to conventional linear control in theory and application.

The goal is a mapping of these ideas into the application area on a research –oriented level with a deeper insight into modern advanced control technology and systems theory. Presentation and discussion of theory and of results of practical exercises in a scientific research oriented way in English.

Knowledge Prerequisites:
A basic lecture in feedback control systems is required for this module with the following topics

- Differential equations, Linear time invariant (LTI)- system modelling, Linear control loop elements
- Basic understanding of block diagrams
- Linear versus nonlinear models and basic linearization
- Transfer functions, frequency response
- Development and Simulation (e.g. Matlab Simulink) of PID controllers for LTI-systems
- Stability and at least one Criteria (Nyquist or *Routh*-Hurwitz criterion)
- Basic tuning (e.g. Ziegler and Nichols) and evaluation of controlled loops by performance criteria

7. INDICATIVE SYLLABUS CONTENT – the topics you may encounter on this module include:

State Space:
State space modelling of dynamical systems – theory and applications
State space equations and transfer functions,
Stability, Controllability, Observability,
State feedback control design
Comparison conventional control with PID and transfer functions to state space controlled system.
Simulation of state space system using Matlab Simulink

Linear and Nonlinear Control:
Fuzzy Control: Methods and Concepts for modelling and control, Fuzzy Controller (e.g. Mandami Controller) in application (Matlab Simulink simulations). Neural Network Control: Methods and Concepts for modelling and control, Multi-layer Perceptron, Back Propagation, Neural Controller in applications, Matlab Programming.
Comparison of these techniques with a linear approximated control model near an equilibrium point in applications (e.g. Water level tank application in our Lab) is given and the limitations of the systems are discussed.

Programming in Matlab and Simulink. Discussion of complex linear and nonlinear problems in the area of control engineering.

8. LEARNING, TEACHING AND ASSESSMENT – this module is delivered and assessed in the following ways:

This module is split between formal lectures, tutorials and computer-based and practical work in the lab. Teaching is based around handouts containing course material and examples of real systems. Assigned reading, tutorial, practical labs and lectures will also be used to import knowledge.
ECTS workload:

Lectures:	50 hours
Computer based exercises and lab:	30 hours
Discussion / Review /Tutorial:	25 hours
Coursework:	2 x 30 hours
Directed reading:	25 hours
Exam preparation:	50 hours
Total No Hours	**240 hours**

9. Learning Outcomes and Assessment Criteria:			
LEARNING OUTCOMES – when you have successfully completed this module you will:		**ASSESSMENT CRITERIA - to demonstrate that you will have achieved the learning outcome you will:**	
1	Be able to describe dynamical systems in mathematical terms using state space representations, block diagrams or transfer functions and compare the advantages and disadvantages.	1	Develop a detailed understanding of modelling for linear and nonlinear time invariant plants in engineering with different methods and understand their properties. Point out the advantages and disadvantages of using different methods in modelling
2	Understand to design controllers using state space pole assignment and/or observers Compare solutions to conventional controller e.g. Phase lead and phase lag feedback compensators, Case studies	2	You will be able to design a state space controller and analyse its advantage and disadvantages to conventional PID controllers, implemented with transfer functions.
3	Have knowledge about fuzzy mathematics and many-valued logic. Be able to design a fuzzy controller.	3	Analyse the requirement and derive technical specifications for fuzzy systems. You are able to design a fuzzy controller with own coding in Matlab and to evaluate its performance compared to other methods.
4	Understand the theory of neural networks. Be able to design and implement a neural controller with Back Propagation algorithm.	4	Evaluate, select and use appropriate data and design for the development of a neural controller. You are able to compare the performance to other solutions and you can explain the advantages and disadvantages.

10: ASSESSMENT ITEMS – your achievement of the learning outcomes for this module will be tested as follows:

Assessment type:	**Combined form of examinations**	
	ASSESSMENT ITEM NUMBER	
	1	**2**
Type	**PRA, PRE, CW**	**EX**
Description	E.g.: a) The task is to control a given plant using different techniques. There will be a simulation in Matlab Simulink and practical application in the lab. In a presentation you will show your solution and answer questions. or b) Analysis, design and implementation task. Assessment will be based on quality of analysis, theoretical background knowledge, design, function, documentation.	Examination (written, 2 hours)
Percent of mark	**50**	**50**

Each assessment item in the module to be entered separately

Type:
- AO - Attendance only
- Cw - Coursework
- EX - Examination
- ICA - In-class Assignment
- PRA - Practical work
- PRE - Presentation
- IS - Independent Study, dissertation or project

Description – Text description of type of assessment. For example:

- Cw - Essay of 2,000 words
- EX - Open Book examination
- IS - Dissertation, 10,000 words

Percentage of Mark - Percentage weighting for each item of assessment

11. INDICATIVE READING - amongst some of the materials you may be required to consult are: (up to 15 titles with date of publication)

Åström, K. J., Murray, R. M: Feedback Systems: An Introduction for Scientists and Engineers: *Princeton University Press, 2008*

Ogata K.: Modern Control Engineering: Fifth Edition: *Pearson, 2009*

Dorf R., Bishop R.: Modern Control Systems: Twelfth Edition (Intl. Ed.): *Pearson, 2010.*

Franklin, G., Powell, D. und Emami-Naeini, A.: Feedback Control of Dynamic Systems, Reading: Sixth Edition: Prentice Hall, 2008

Messner B., Tilbury D.: Control Tutorials for Matlab&Simulink, http://ctms.engin.umich.edu/CTMS/index.php?aux=Home 2012

Winston P.: Learning: Neural Nets, Back propagation, MIT OpenCourseWare MIT 6.034 Artificial Intelligence, Fall 2010 http://ocw.mit.edu/6-034F10

Hines, Wesley: Fuzzy and Neural Approaches in Engineering MATLAB Supplement, Wiley Series on Adaptive and Learning Systems for Signal Processing Communications and Control. Simon Haykin, 1997

Lecture notes: Advanced Control: S. Hafner, South Westphalia University of Applied Sciences

12. VERSION NUMBER:	**1.0**

2 Advanced Control Technology (ME / MT)

1. CODE	**EEM4015-2**
2. TITLE	**Advanced Control Technology (ME / MT)**
3. PATHWAY	**ME / MT**
4. INSTRUCTOR	**Prof. Dr.-Ing. Andreas Schwung**
5. CREDITS	**ECTS 8 (15)**

6. DESCRIPTION AND PURPOSE OF MODULE – studying this module involves the following:

This research-oriented module enables the student to understand modern control techniques and the basic principles of Computational Intelligence often called Soft Computing with the two parts Neural Networks and Fuzzy Systems. The student should be familiar with the analytical methods of modelling and design of intelligent and cognitive systems for modern control and management. The goal is a mapping of the novel ideas into the application area on a research –oriented level with a deeper insight into modern advanced control technology and systems theory.

7. INDICATIVE SYLLABUS CONTENT – the topics you may encounter on this module include:

The module covers the area of advance control technology with special emphasis on the design of control systems for mechanical 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
Interactive programming, use of menu systems
Understand the limitation of simulation systems
Design of interactive models.
Simulation and model based design of control systems

Modelling and control of mechanical systems
Control oriented modelling with special emphasis on mechanical systems
Controller design based on frequency response method
State-Space approach
Design of state feedback controller and state feedback observer
Stability of dynamic systems
Nonlinear System Analysis
Nonlinear Controller design based on feedback linearization
Model Predictive control
Fuzzy Systems
Fuzzy Control

8. LEARNING, TEACHING AND ASSESSMENT – this module is delivered and assessed in the following ways:

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.
ECTS workload:

Lectures:	60 hours
Computer based exercices:	20 hours
Discussion / Review / Tutorial:	25 hours
Coursework:	60 hours
Directed reading:	25 hours
Exam preparation:	50 hours
Total No Hours	**240 hours**

9. Learning Outcomes and Assessment Criteria:			
LEARNING OUTCOMES – when you have successfully completed this module you will:		**ASSESSMENT CRITERIA - to demonstrate that you will have achieved the learning outcome you will:**	
1	Be able to develop models of engineering systems in the field of electrical and mechanical engineering.	1	Constitute the differential equations of a system from its given attributes. Generate the state equations from a differential equation n^{th} order. Generate state space system from a given system description.
2	Be able to use current software simulation tools	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	Be able to analyse nonlinear systems and design controller for them	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 criterias.
4	Be able to design and implement fuzzy systems	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.

10: ASSESSMENT ITEMS – your achievement of the learning outcomes for this module will be tested as follows:

Assessment type:	**Combined form of examinations**	
	ASSESSMENT ITEM NUMBER	
	1	**2**
Type	**PRA, PRE, CW**	**EX**
Description	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.	Examination (written, 2hours)
Percent of mark	**50**	**50**

Each assessment item in the module to be entered separately

Type:
- AO - Attendance only
- Cw - Coursework
- EX - Examination
- ICA - In-class Assignment
- PRA - Practical work
- PRE - Presentation
- IS - Independent Study, dissertation or project

Description – Text description of type of assessment. For example:

- Cw - Essay of 2,000 words
- EX - Open Book examination
- IS - Dissertation, 10,000 words

Percentage of Mark - Percentage weighting for each item of assessment

11. INDICATIVE READING - amongst some of the materials you may be required to consult are: (up to 15 titles with date of publication)

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.
Dayhoff J E, Neural Network Architectures: An Introduction, Van Nostrand Reinhold 1990.
Kosko B, Neural Networks and Fuzzy Systems, Prentice Hall, 1992.
Lisboa P G J, Neural Networks: Current Applications, Chapman and Hall, 1992.
D.Driankov, H.Hellendoorn, M.Reinfrank, An Introduction to Fuzzy Control, Springer-Verlag, Heidelberg (1992).
Y.-H.Pao: Adaptive Pattern Recognition and Neural Networks, Addison-Wesley Pub.Comp., New York (1989).
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).

12. VERSION NUMBER:	**1.0**

3 Advanced Production Engineering

1. CODE	**EEM4019**
2. TITLE	**Advanced Production Engineering**
3. PATHWAY	**ME / MT**
4. INSTRUCTOR	**Prof. Dr.-Ing. Thorsten Frank**
5. CREDITS	**ECTS 8 (15)**

6. DESCRIPTION AND PURPOSE OF MODULE – studying this module involves the following:

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.

7. INDICATIVE SYLLABUS CONTENT – the topics you may encounter on this module include:

- 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

8. LEARNING, TEACHING AND ASSESSMENT – this module is delivered and assessed in the following ways:

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.

ECTS workload:

Lectures:	55 hours
Computer based exercises	0 hours
Discussion / Review / Tutorial:	55 hours
Coursework:	3 x 30 hours
Directed reading:	40 hours
Total No. Hours	240 hours

9. Learning Outcomes and Assessment Criteria:

	LEARNING OUTCOMES – when you have successfully completed this module you will:		**ASSESSMENT CRITERIA - to demonstrate that you will have achieved the learning outcome you will:**
1	have a systematic understanding of modern advanced mechanical systems with manufacturing or assembly processes and production management for flexible customized series production	1	• have communication and presentation skills appropriate to modern production systems in different branches

2	have understanding of industrial processes for production system environment and network	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	have knowledge of improvement tools and techniques in different contexts based on Lean philosophy	3	• able to undertake successfully an extended project in failure and process analysis
4	have a comprehensive knowledge of methods, and tools to manage complexity and control of advanced production systems	4	• have to skills to optimize the value stream with help of important lean elements

10: ASSESSMENT ITEMS – your achievement of the learning outcomes for this module will be tested as follows:

Assessment type:	**Project work**
	ASSESSMENT ITEM NUMBER
	1
Type	**CW, PRE, PRA**
Description	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
Percent of mark	**100**

Each assessment item in the module to be entered separately

Type: AO - Attendance only
Cw - Coursework
EX - Examination
ICA - In-class Assignment
PRA - Practical work
PRE - Presentation
IS - Independent Study, dissertation or project

Description – Text description of type of assessment. For example:
Cw - Essay of 2,000 words
EX - Open Book examination
IS - Dissertation, 10,000 words

Percentage of Mark - Percentage weighting for each item of assessment

11. INDICATIVE READING - amongst some of the materials you may be required to consult are: (up to 15 titles with date of publication)

[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

12. VERSION NUMBER:	**1.0**

4 Business in Engineering

1. CODE	**EEM4013**
2. TITLE	**Business in Engineering**
3. PATHWAY	**ET / ME / MT**
4. INSTRUCTOR	**Prof. Dr. Henrik Janzen**
5. CREDITS	**ECTS 7(15)**

6. DESCRIPTION AND PURPOSE OF MODULE – studying this module involves the following:

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.

7. INDICATIVE SYLLABUS CONTENT – the topics you may encounter on this module include:

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
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
Analyzing strengths and weaknesses, opportunities and threats in competition
Defining the marketing-mix: product development, pricing, communication and distribution

8. LEARNING, TEACHING AND ASSESSMENT – this module is delivered and assessed in the following ways:

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.
ECTS workload:

Lectures	60 hours
Discussion /review /tutorial	40 hours
Coursework	80 hours
Directed reading	30 hours
Total No Hours	210 hours

9. Learning Outcomes and Assessment Criteria:

	LEARNING OUTCOMES – when you have successfully completed this module you will:		**ASSESSMENT CRITERIA - to demonstrate that you will have achieved the learning outcome you will:**
1	Have knowledge and understanding of management both as a function and an institution	1	Discuss the focus of Management within the business environment.
2	Have knowledge and understanding of basic management techniques and instruments	2	Describe management Instruments and their conditions for use within business situations.
3	Understand and be able to apply the benefit of management instruments in a practical environment	3	Practice the use of management instruments in realistic business environments as identified in case studies
4	Understand the role of markets in developing and selling of products and technologies	4	Be able to recognise and implement the stages of innovation in taking a product from conception to sales.
5	Have knowledge and understanding of the marketing concept as „market-oriented” management	5	Compare management and marketing conceptions and apply them to typical business environments.
6	Have knowledge and understanding of the principles and instruments of „business to business“-marketing	6	Discuss and compare business-to-business and business-to-consumer marketing, and be able to select models appropriate particular business scenarios.
7	Be able to solve „business to business“-marketing problems (in case studies)	7	Apply business-to-business marketing to practical situations identified in case studies
8	Have knowledge and understanding of technology-selling situations	8	Assess, critically analyse, develop and present a business presentation

10: ASSESSMENT ITEMS – your achievement of the learning outcomes for this module will be tested as follows:	
Assessment type:	**Project work**
	ASSESSMENT ITEM NUMBER
	1
Type	**CW/PRE**
Description	a) Development and presentation of a business-to-business selling situation (role-play) And / or b) Essay about different asserted problems and cases
Percent of mark	**100**

Each assessment item in the module to be entered separately

Type: AO - Attendance only
Cw - Coursework
EX - Examination
ICA - In-class Assignment
PRA - Practical work
PRE - Presentation
IS - Independent Study, dissertation or project

Description – Text description of type of assessment. For example:
Cw - Essay of 2,000 words
EX - Open Book examination
IS - Dissertation, 10,000 words
Percentage of Mark - Percentage weighting for each item of assessment

11. INDICATIVE READING - amongst some of the materials you may be required to consult are: (up to 15 titles with date of publication)

- Babcock, D.L.: Managing Engineering and Technology – An Introduction to Management for Engineers. 6. Ed., London (Prentice Hall) 2013
- Dibb, S.; Simkin, L.: The marketing casebook – cases and concepts. 2. Ed. London/New York (Routledge) 2001
- Hutt, M.D.; Speh, T.W.: Business Marketing Management – a strategic view of industrial and organizational markets. 10. Ed., Fort Worth u.a.O (Dryden Press) 2009
- Jobber, D.: Principles and Practice of Marketing. 7. Ed. London u.a.O. (Mc Graw-Hill) 2012
- Kotler, P.: Marketing Management. 14. Ed., London u.a.O. (Prentice Hall) 2011
- Lawless, M.W.; Gomez-Mejia, L.R. (Edts.): Strategic Management in High Technology Firms. Greenwich/London (JAI Press) 1990
- Lovelock, C.H.; Weinberg, C.B.: Marketing Challenges – Cases and Exercises. 3. Ed., New York u.a.O. (Mc Graw-Hill) 1993
- Mead, R.: Cases and Projects in International Management. Oxford (Blackwell) 2000
- Mintzberg, H.; Quinn, J.B.: The Strategy Process – Concepts, Contexts, Cases. 4. Ed., London u.a.O. (Prentice-Hall) 2002

12. VERSION NUMBER:	**1.0**

5 Integrated Management Systems

1. CODE	**EEM4020**
2. TITLE	**Integrated Management Systems**
3. PATHWAY	**ET / ME / MT**
4. INSTRUCTOR	**Prof. Dr. Andreas Gerlach**
5. CREDITS	**ECTS 7 (15)**

6. DESCRIPTION AND PURPOSE OF MODULE – studying this module involves the following:

The module offers an introduction into integrated management systems (IMS). Increasing complexity and the dynamics of challenges that have to be mastered by an organisation's management has led to a high degree of specialisation and division of work. However, isolated solutions for individual problems are not efficient. Therefore, an integrated management system (IMS) combines all related components of a business into one system for more efficient management and operations. Quality, Environmental, and Safety management systems are often combined and managed as an IMS. These systems are not separate systems that are later combined, rather they are integrated with linkages so that similar processes are seamlessly managed and executed without duplication.
The course introduces tools and methods of holistic approaches to quality management and environmental management. In addition, the course will provide an introduction into innovation management and the challenge of integrating innovation into an organization's IMS.

7. INDICATIVE SYLLABUS CONTENT – the topics you may encounter on this module include:

Quality Management:
- Perspectives on quality
- Objectives of integrated quality management systems
- ISO 9000 systems
- Total Quality Management
- Six Sigma

Environmental Management:
- Objectives and motivation of environmental protection
- Activities and procedures to set up an EMS
- Environmental policy and review
- Structure of ISO14000/14001
- Environmental Management Manual

Innovation Management:
- Solution oriented creativity techniques
- Invention vs. Innovation
- Innovation management : Principles, tools and methods
- Project assessment and selection
- Implementation of innovation
- Capturing innovation

8. LEARNING, TEACHING AND ASSESSMENT – this module is delivered and assessed in the following ways:

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.
ECTS workload:

Lectures:	50 hours
Computer based exercises	20 hours
Discussion / Review / Tutorial:	20 hours
Coursework:	3 x 20 & 1 x 30 hours
Directed reading:	30 hours
Total No. Hours	210 hours

9. Learning Outcomes and Assessment Criteria:

	LEARNING OUTCOMES – when you have successfully completed this module you will:		**ASSESSMENT CRITERIA - to demonstrate that you will have achieved the learning outcome you will:**
1	have a good understanding of integrated management systems		be able to reflect the necessity of integrating management systems
2	understand the nature and of quality management, and environmental management as holistic approaches		be able to explain relevant management methods and tools for successful quality management and environmental management
3	be able to successfully contribute to TQM-, ISO 9000-, Six Sigma-, and ISO 14000/14001 processes in organizations		be able to describe and analyse case studies in the area of quality management and environmental management
4	understand innovation management as a process and a major management responsibility		be able to explain and apply relevant methods and tools for project search, selection, implementation and capturing

10: ASSESSMENT ITEMS – your achievement of the learning outcomes for this module will be tested as follows:	
Assessment type:	**Project work**
	ASSESSMENT ITEM NUMBER
	1
Type	**CW/PRE**
Description	a) Assignment related to quality management or environmental management in an organisation and / or b) Assignment related to innovation management in an organisation
Percent of mark	**100**

Each assessment item in the module to be entered separately

Type: AO - Attendance only
Cw - Coursework
EX - Examination
ICA - In-class Assignment
PRA - Practical work
PRE - Presentation
IS - Independent Study, dissertation or project

Description – Text description of type of assessment. For example:
Cw - Essay of 2,000 words
EX - Open Book examination
IS - Dissertation, 10,000 words
Percentage of Mark - Percentage weighting for each item of assessment

11. INDICATIVE READING - amongst some of the materials you may be required to consult are: (up to 15 titles with date of publication)

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 Clasical 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

12. VERSION NUMBER:	**1.0**

6 International Project Management

1. CODE	**EEM4017**
2. TITLE	**International Project Management**
3. PATHWAY	**ET / ME / MT**
4. INSTRUCTOR	**Prof. Dr. Florian Dörrenberg**
5. CREDITS	**ECTS 7 (15)**

6. DESCRIPTION AND PURPOSE OF MODULE – studying this module involves the following:

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 role as manager has to cooperate with others and has to coordinate the work within projects across functional boundaries. He 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.

7. INDICATIVE SYLLABUS CONTENT – the topics you may encounter on this module include:

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

8. LEARNING, TEACHING AND ASSESSMENT – this module is delivered and assessed in the following ways:

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.

ECTS workload:

Lectures	48 hours
Computer-based exercises	20 hours
Discussion /review /tutorial	30 hours
Assignment preparation and completion	46 hours
Coursework	40 hours
Directed reading	26 hours
Total No. Hours	210 hours

9. Learning Outcomes and Assessment Criteria:

LEARNING OUTCOMES – when you have successfully completed this module you will:		**ASSESSMENT CRITERIA - to demonstrate that you will have achieved the learning outcome you will:**	
1	Understand what characterises a project in terms of cost, time and performance. How these are interpreted as target outcomes of projects.	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	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	2	Be able to explain and apply context-related relevant methods and tools for project selection, initiation and implementation.
5	Have knowledge about the difference between project, program and portfolio and understand the interconnections and priorities in a multi-project environment,		
6	Have a knowledge and understanding of project team members, team psychology and how to motivate the team to meet the commitments of project.	3	Have gained own experience as member of an international project team bridging the gap of language and perception.
7	Have knowledge and understanding of basic project management tools and instruments	4	Practice the use of appropriate project management tools and instruments in realistic business environments as identified in case studies
8	Be able to use a current PM-software tool to develop a basic plan for a project.	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.
9	Have broaden your background knowledge and understanding of advanced PM topics	6	Assess, critically analyse, develop and present a business presentation in the right context

10: ASSESSMENT ITEMS – your achievement of the learning outcomes for this module will be tested as follows:	
Assessment type:	**Project work**
	ASSESSMENT ITEM NUMBER
	1
Type	**CW / PRE / IS / PRA**
Description	**a) Team-Presentation about an advanced topic in Project Management** **And / or** **b) Learning Logbook** Written report with a very individual reflection on 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** Student 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 optimization the usage of project resources.
Percent of mark	**100**

Each assessment item in the module to be entered separately

Type:
- AO - Attendance only
- Cw - Coursework
- EX - Examination
- ICA - In-class Assignment
- PRA - Practical work
- PRE - Presentation
- IS - Independent Study, dissertation or project

Description – Text description of type of assessment. For example:
- Cw - Essay of 2,000 words
- EX - Open Book examination
- IS - Dissertation, 10,000 words

Percentage of Mark - Percentage weighting for each item of assessment

11. INDICATIVE READING - amongst some of the materials you may be required to consult are: (up to 15 titles with date of publication)

- **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

12. VERSION NUMBER:	**1.0**

7 Microprocessor Based Systems

1. CODE	**EEM4016**
2. TITLE	**Microprocessor Based Systems**
3. PATHWAY	**ET / MT**
4. INSTRUCTOR	**Prof. Dr.-Ing. Werner Krybus**
5. CREDITS	**ECTS 8 (15)**

6. DESCRIPTION AND PURPOSE OF MODULE – studying this module involves the following:

To select and use appropriate microprocessor hardware and software to solve real-time embedded system monitoring and control design problems.

7. INDICATIVE SYLLABUS CONTENT – the topics you may encounter on this module include:

Basic principles of digital systems:
Digital versus analogue electronics
Digital logic, Logic families, functions and gates, Memory types
Microprocessor architectures:
Comparison of 8,16,32 bit microprocessors, microcontrollers and RISC microprocessors
Instruction sets, architecture, speed, cost, support chips, interrupt facilities
Memory and peripheral devices
Software Development:
Comparison of low and high level languages
Use of C to program microprocessors/microcontrollers
Code generation procedures. Structured programming techniques
Creation of re-usable library functions.
Software testing procedures.
Development of embedded microprocessor systems:
Design of a system to meet the technical requirements of a specified engineering problem
Incorporation of interrupts, parallel and serial interfaces, power control
Requirements analysis and specification
Hardware and software partitioning
Project planning and time tabling, cost analysis, documentation archiving procedures
Use of In Circuit Emulators and debugger tools
System testing techniques
Transducers and the interfacing of analogue and digital circuits:
Overview of transducer types with emphasis on interfacing methods to microprocessor based systems
Signal sampling, Analogue and digital signals
Digital to analogue conversion, Analogue to digital conversion
Performance specifications
Applications in the automobile industry.
Data communications:
Alphanumeric codes and serial communications
An overview of interface standards such as RS232C, USB, I2C.

8. LEARNING, TEACHING AND ASSESSMENT – this module is delivered and assessed in the following ways:

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.

ECTS workload:

Lectures	30 hours
Computer-based exercises	40 hours
Discussion /review /tutorial	30 hours
Coursework	2 x 30 hours
Directed reading	30 hours
Exam preparation	50 hours
Total:	240 hours

9. Learning Outcomes and Assessment Criteria:

	LEARNING OUTCOMES – when you have successfully completed this module you will:		**ASSESSMENT CRITERIA - to demonstrate that you will have achieved the learning outcome you will:**
1	Have knowledge and understanding of the main concepts, interfaces and peripheral components associated with microprocessor based systems	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 a typical microcontroller.

2	Have knowledge and understanding of the development tools for microprocessor based systems	2	Evaluate, select and use appropriate design tools for the development of microprocessor based systems.
3	Have skills in design and developing of software for embedded systems in 'C' have skills in testing microcontroller systems and using design tools such as Integrated Development Environments and In Circuit Emulators	3	Develop software to use the peripheral components of a microcontroller (IO Ports, AD-Converter, Timer) and integrate them to application programs.
4	Be able to design and implement microcontroller systems for - signal processing - simple control applications - intelligent systems	4	Analyse requirements and derive a technical specification. Design and implement a system to meet the technical requirements.

10: ASSESSMENT ITEMS – your achievement of the learning outcomes for this module will be tested as follows:

Assessment type:	**Combined form of examinations**	
	ASSESSMENT ITEM NUMBER	
	1	**2**
Type	**PRA: CW**	**EX**
Description	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	Examination (written, 2 hours)
Percent of mark	**50**	**50**

Each assessment item in the module to be entered separately
Type: AO - Attendance only
Cw - Coursework
EX - Examination
ICA - In-class Assignment
PRA - Practical work
PRE - Presentation
IS - Independent Study, dissertation or project
Description – Text description of type of assessment. For example:
Cw - Essay of 2,000 words
EX - Open Book examination
IS - Dissertation, 10,000 words
Percentage of Mark - Percentage weighting for each item of assessment

11. INDICATIVE READING - amongst some of the materials you may be required to consult are: (up to 15 titles with date of publication)

Lecture notes W. Krybus, South-Westphalia University of Applied Sciences
Programming and Customizing the AVR Microcontroller, Dhananjay V. Gadre, McGraw-Hill, 2001
Embedded Microprocessor Systems: Real World Design, Stuart R. Ball, Butterworth-Heinemann, 2002
C Programming for Embedded Microcontrollers, Warwick A. Smith, Elektor Publishing, 2009
AVR Microcontroller and Embedded Systems, Muhammad Ali Mazidi et. al., Prentice Hall, 2010
Make: AVR Programming: Learning to Write Software for Hardware, Elliot Williams, Maker Media, Inc, 2014
Atmel Web Site: www.atmel.com

12. VERSION NUMBER:	**1.0**

8 Modelling and Simulation of Mechanical Systems

1. CODE	**EEM4018**
2. TITLE	**Modelling and Simulation of Mechanical Systems**
3. PATHWAY	**ME**
4. INSTRUCTOR	**Prof. Dr.-Ing. Alfons Noe**
5. CREDITS	**ECTS 8 (15)**

6. DESCRIPTION AND PURPOSE OF MODULE – studying this module involves the following:

The student learns that thorough modelling of mechanical components and technical systems and combined numerical simulation methods, by commercialized software packages, have enabled, improved, accelerated virtual CAX-product design, functional analysis, manufacturing or fault analysis. Established results are available in automotive, aircraft, aerospace, semiconductors, robotics, tooling machines, trains, wind mills, and others.

First, the Finite Element Method (FEM) will be addressed, which allows to determine fields for displacements, strain and stress tensors as well as heat flux and temperature fields from mechanical and thermal loadings under static, dynamic and thermal load conditions. Nonlinearities from finite deformations, nonlinear material laws (plasticity, creep, rubber) and contact between parts will also be covered. Second, the dynamics of assembled multiple body sets connected by joints, springs and dampers as well as the associated Multi Body Simulation (MBS) will be treated. MBS provides full quantitative result sets of nonlinear kinematics as well as forces and torques.

7. INDICATIVE SYLLABUS CONTENT – the topics you may encounter on this module include:

Finite Element Method (FEM)

- Solid Mechanics (kinematic of deformation, strain and stress tensors, material laws (thermo-elasticity, plasticity, creep, viscoelasticity, rubber), contact mechanics
- Weak Formulation of thermo-mechanical systems (variational principals, Galerkin method, static, dynamic)
- Discretization (p-method vs. h-method, iso-parametric concept, element types, meshing techniques
- Numerical simulation (solving nonlinear equation systems, implicit and explicit integration methods)
- Application of a professional FEM-software to a small industry-like project

Multi Body Simulation (MBS)

- Kinematics (Degree of Freedom, rotations (Euler-, Byrant angles), constraints, loops, minimal coordinates)
- Kinetics (Newton Euler-Equations, Lagrange Equations of 1^{st}, 2^{nd} type, Differential Algebraic Equations)
- Assembly of MBS-systems, load application, analysis requests and visualization
- Numerical Integration methods and properties (stiffness, DAE-systems/-index, integrator features: BDF (esp. Gear´s method), corrector-predictor, Newton-Raphson-Method, simulation control)
- Application of a professional MBS-software to a small industry-like project

8. LEARNING, TEACHING AND ASSESSMENT – this module is delivered and assessed in the following ways:

This module is divided into formal lectures to outline the theoretical background, followed up by further assigned reading and working out small mathematical models a part of the assignment. One simple hand model shall be analyzed for characteristic features theoretically. Their behavior has to be simulated by tools like MS.Excel, MatLab or Maple. Based on acquired knowledge and experiences with small models the student shall work out a more complex industry-like assignment problem by using the available professional simulation software, where in general the selection out of a FEM- or MBS-project will be prescribed by the instructor. A supervised introduction to the software tool will be provided. For the assessment a report must be submitted, presented and defended. The course will close with a written examination covering the lecture contents and the assignment project.

ECTS workload:

Lectures	50 hours
Computer-based exercises	60 hours
Discussion /review /tutorial	20 hours
Coursework	50 hours
Directed reading	20 hours
Exam preparation	40 hours
Total No. Hours	240 hours

9. Learning Outcomes and Assessment Criteria:

	LEARNING OUTCOMES – when you have successfully completed this module you will:		**ASSESSMENT CRITERIA - to demonstrate that you will have achieved the learning outcome you will:**
1	have knowledge and understanding of the theory of structural and dynamic mechanical components	1	be able to build simple classroom-level physical models and generate associated mathematical models
2	have knowledge and understanding on solving differential equations for 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 create a computational model in a complex a 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.	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, beyond compiling a report.
4	Be able to analyse and critically assess features extracted from numerical simulation software tool.	4	develop a systematic approach by adopting heuristic reasoning and develop test scenarios with known limits of analytic solutions and /or experimental results.

10: ASSESSMENT ITEMS – your achievement of the learning outcomes for this module will be tested as follows:

Assessment type:	**Combined form of examinations**	
	ASSESSMENT ITEM NUMBER	
	1	**2**
Type	**PRA, CW, PRE**	**EX**
Description	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- or MBS-software, simulate, analyse, assess, recommend. Assessment based on report, presentation and defending.	Examination (written, 2 hours)
Percent of mark	**50**	**50**

Each assessment item in the module to be entered separately

Type: AO - Attendance only
Cw - Coursework
EX - Examination
ICA - In-class Assignment
PRA - Practical work
PRE - Presentation
IS - Independent Study, dissertation or project

Description – Text description of type of assessment. For example:
Cw - Essay of 2,000 words
EX - Open Book examination
IS - Dissertation, 10,000 words
Percentage of Mark - Percentage weighting for each item of assessment

11. INDICATIVE READING - amongst some of the materials you may be required to consult are: (up to 15 titles with date of publication)

- 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-Verlag (2006).
- 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) or Prentice Hall (1987).
- 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).
- Nikravesh, P. E.: Planar Multbody Dynamics, CRC Press (2008).
- Öchsner, A., Merkel, M.: One Dimensional Finite Element Method, Springer-Verlag (2013).
- Preumont, A.: Twelve Lectures on Structural Dynamic. Springer-Verlag, Berlin (2013).
- Schramm, D., Hiller M., Bardini, R.: Vehicle Dynamics, Springer-Verlag (2014).
- Shabana, A. A.: Dynamics of Multibody Systems, Cambridge University Press (2013).

12. VERSION NUMBER:	**1.0**

9 Signal Processing

1. CODE	**EEM4011**
2. TITLE	**Signal Processing**
3. PATHWAY	**ET**
4. INSTRUCTOR	**Prof. Dr.-Ing. Ulf Witkowski**
5. CREDITS	**ECTS 8 (15)**

6. DESCRIPTION AND PURPOSE OF MODULE – studying this module involves the following:

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.

7. INDICATIVE SYLLABUS CONTENT – the topics you may encounter on this module include:

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

8. LEARNING, TEACHING AND ASSESSMENT – this module is delivered and assessed in the following ways:

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.

ECTS workload:

Lectures:	45 hours
Computer based exercises:	30 hours
Discussion / review / tutorial:	25 hours
Coursework:	60 hours
Directed reading:	30 hours
Exam preparation:	50 hours
Total :	240 hours

9. Learning Outcomes and Assessment Criteria:

	LEARNING OUTCOMES – when you have successfully completed this module you will:		**ASSESSMENT CRITERIA - to demonstrate that you will have achieved the learning outcome you will:**
1	Have knowledge and understanding of the theory of signal processing, time and frequency domain, analogue and digital signals	1	Be able to apply signal processing theory to practical situations
2	Have knowledge and understanding of the theory of filtering signals	2	Be able to apply to engineering scenarios and analyse performance through simulation
3	Be able to analyse and critically assess a system to apply signal processing simulation	3	Be able to set up different engineering application simulations and critically assess system performance to a variety of stimulations
4	Be able to develop measurement chains in practical application	4	Develop a systematic approach to data acquisition for signal processing
5	Have skills to apply data acquisition, analysis and visualisation tools to relevant application areas	5	Design measurement and simulation systems for practical engineering applications

10: ASSESSMENT ITEMS – your achievement of the learning outcomes for this module will be tested as follows:

Assessment type:	**Combined form of examinations**	
	ASSESSMENT ITEM NUMBER	
	1	**2**
Type	**PRA: CW**	**EX**
Description	E.g.: a) Develop measurement chain to acquire process 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	Examination (written, 2 hours)
Percent of mark	**50**	**50**

Each assessment item in the module to be entered separately

Type: AO - Attendance only
Cw - Coursework
EX - Examination
ICA - In-class Assignment
PRA - Practical work
PRE - Presentation
IS - Independent Study, dissertation or project

Description – Text description of type of assessment. For example:
Cw - Essay of 2,000 words
EX - Open Book examination
IS - Dissertation, 10,000 words
Percentage of Mark - Percentage weighting for each item of assessment

11. INDICATIVE READING - amongst some of the materials you may be required to consult are: (up to 15 titles with date of publication)

- 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

12. VERSION NUMBER:	**1.0**

10 Systems Engineering

1. CODE	**EEM4011**
2. TITLE	**Systems Engineering**
3. PATHWAY	**ET / ME / MT**
4. INSTRUCTOR	**Prof. Dr.-Ing. Andreas Schwung, Prof. Dr. rer.nat Stefan Schweizer**
5. CREDITS	**ECTS 8 (15)**

6. DESCRIPTION AND PURPOSE OF MODULE – studying this module involves the following:

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.

7. INDICATIVE SYLLABUS CONTENT – the topics you may encounter on this module include:

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 system 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.

8. LEARNING, TEACHING AND ASSESSMENT – this module is delivered and assessed in the following ways:

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.
ECTS workload:

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**

9. Learning Outcomes and Assessment Criteria:

	LEARNING OUTCOMES – when you have successfully completed this module you will:		**ASSESSMENT CRITERIA - to demonstrate that you will have achieved the learning outcome you will:**
1	Be able to critically review and apply the principles of systems engineering to the practical problems of product lifecycle management	1	- develop confidence in using systems concepts - understand systems engineering process models, methods and tools for the development of complex systems
2	Be able to develop knowledge and evaluate the system design requirements and validation.	2	explain the system development process, including requirements for systems reliability
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.	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

10: ASSESSMENT ITEMS – your achievement of the learning outcomes for this module will be tested as follows:		
Assessment type:	**Combined form of examinations**	
	ASSESSMENT ITEM NUMBER	
	1	**2**
Type	**CW**	**EX**
Description	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	Examination (written, 2 hours)
Percent of mark	**50**	**50**

Each assessment item in the module to be entered separately

Type:	AO	- Attendance only
	Cw	- Coursework
	EX	- Examination
	ICA	- In-class Assignment
	PRA	- Practical work
	PRE	- Presentation
	IS	- Independent Study, dissertation or project

Description – Text description of type of assessment. For example:

	Cw	- Essay of 2,000 words
	EX	- Open Book examination
	IS	- Dissertation, 10,000 words
Percentage of Mark		- Percentage weighting for each item of assessment

11. INDICATIVE READING - amongst some of the materials you may be required to consult are:
(up to 15 titles with date of publication)

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

12. VERSION NUMBER:	**1.0**

11 Technical Publications and Presentations

1. CODE	**EEM4014**
2. TITLE	**Technical Publications and Presentations**
3. PATHWAY	**ET / ME / MT**
4. INSTRUCTOR	**Marga Taylor**
5. CREDITS	**ECTS 7 (15)**

6. DESCRIPTION AND PURPOSE OF MODULE – studying this module involves the following:

Enabling the student

- to plan, compose and present 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.

7. INDICATIVE SYLLABUS CONTENT – the topics you may encounter on this module include:

Preparing scientific and technical publications:
Abstracts
Papers

Presentations:
Oral presentations
Poster presentations

Information acquisition:
Research in data-bases
Electronic communication systems (e.g. WWW)

8. LEARNING, TEACHING AND ASSESSMENT – this module is delivered and assessed in the following ways:

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 of abstracts and papers as well as oral presentation.
ECTS workload:

Lectures:	45 hours
Discussion / Review / Tutorial:	55 hours
Assignment preparation and completion:	2 x 40 hours
Directed reading:	30 hours
Total No Hours	**210 hours**

9. Learning Outcomes and Assessment Criteria:

	LEARNING OUTCOMES – when you have successfully completed this module you will:		**ASSESSMENT CRITERIA - to demonstrate that you will have achieved the learning outcome you will:**
1	Be able to prepare abstracts and papers intended for scientific and technical publications	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 form of communication (description, analysis, summary etc.).
2	Be able to supply correct references to support assertions and to acknowledge ideas and material borrowed from other sources	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 materials

3	Be able to elucidate and discuss papers in oral presentation	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.

10: ASSESSMENT ITEMS – your achievement of the learning outcomes for this module will be tested as follows:

Assessment type:	**Project work**
	ASSESSMENT ITEM NUMBER
	1
Type	**CW/PRE**
Description	Written assignment about a technical topic. Extent: ~4000 words and oral presentation using slides or Power Point. Duration: ~20 min.
Percent of mark	**100**

Each assessment item in the module to be entered separately

Type: AO - Attendance only
Cw - Coursework
EX - Examination
ICA - In-class Assignment
PRA - Practical work
PRE - Presentation
IS - Independent Study, dissertation or project

Description – Text description of type of assessment. For example:
Cw - Essay of 2,000 words
EX - Open Book examination
IS - Dissertation, 10,000 words

Percentage of Mark - Percentage weighting for each item of assessment

11. INDICATIVE READING - amongst some of the materials you may be required to consult are: (up to 15 titles with date of publication)

H. Ebel, C. Bliefert, and W. Russey, The Art of Scientific Writing (VCR. Weinheim, 1987).
Robert A. Day, How to Write and Publish a Scientific Paper (ISI, Philadelphia, 1979).
Matt Young, The Technical Writer's Handbook (University Science Books, Mill Valley, CA, 1989).
The Chicago Manual of Style, 13th ed. (University of Chicago, Chicago, 1982).
Sir Ernest Gowers, The Complete Plain Words, 3rd ed. (Her Majesty's Stationery Office, London, 1986).
H. W. Fowler, A Dictionary of Modern English Usage, 2nd ed. (Oxford University, New York, 1965).
William Strunk, Jr. and E. B. White, The Elements of Style, 3rd ed. (Macmillan, New York, 1979).
Edward R. Tufte, The Visual Display of Quantitative Information (Graphics Press, Cheshire, CT, 1989).
Webster's Third New International Dictionary, unabridged, 3rd ed. (G. & C. Merriam, Springfield, MA, 1986).
Webster's Ninth New Collegiate Dictionary (G. & C. Merriam, Springfield, MA, 1985).
E. Richard Cohen and Pierre Giacomo, Symbols, Units, Nomenclature and Fundamental Constants in Physics [International Union of Pure and Applied Physics, Document IUPAP-25 (SUNAMCO 87-1),1987].
Units of Measurement, ISO Standards Handbook 2 (International Organization for the Standardization, Geneva, Switzerland, 1982).
Peggy Judd, Physical Review Input Guide for Author Prepared Compuscripts, 1st ed. (American Physical Society, New York, 1983).
L. Lamport., A Document Preparation System. Addison-Wesley, 1986.
Antion, Tom, Wake ‘em Up: How to Use Humor and Other Professional Techniques to Create Alarmingly Good Business Presentations. Anchor Publishing, Jan. 1999.

12. VERSION NUMBER:	**1.0**