Appendix A

Recommended course schedule for the combined part-time master's degree study in Applied Automation starting studies in the winter semester

Please note: The German version of this document is the legally binding version. The English translation provided here is for information purposes only.

First semester	**ECTS**	**SCH**	**L**	**ST**	**E**	**P**	**Classroom teaching**
Digital Signal Processing and Controls	6	4	2	-	1	1	24
Distributed Automation Systems	6	4	2	-	1	1	24
Intellectual Property and Competition Law	6	4	2	-	2	-	16
Technology and Innovation Management	6	4	2	-	2	-	16
Totals	**24**	**16**	**8**	**-**	**6**	**2**	**80**
Second semester	**ECTS**	**SCH**	**L**	**ST**	**E**	**P**	**Classroom teaching**
Drive Systems and Drive Controls	6	4	2	-	1	1	24
Modelling and Simulation of Dynamic Systems	6	4	2	-	2	-	16
Embedded Systems and Software Engineering	6	4	2	-	2	-	16
Industrial Bus Technology and Communication	6	4	2	-	1	1	24
Totals	**24**	**16**	**8**	**-**	**6**	**2**	**80**
Third semester	**ECTS**	**SCH**	**L**	**ST**	**E**	**P**	**Classroom teaching**
Handling Technology and Robotics	6	4	2	-	1	1	24
Image-Based Automation Technology	6	4	2	-	1	1	24
Data Management / Big Data Analytics	6	4	2	-	2	-	16
Totals	**18**	**12**	**6**	**-**	**4**	**2**	**64**
Fourth semester	**ECTS**	**SCH**	**L**	**ST**	**E**	**P**	**Classroom teaching**
Master Thesis	20	-	-	-	-	-	-
Colloquium	4	-	-	-	-	-	-
Totals	**24**	**-**	**-**	**-**	**-**	**-**	**-**
Totals	**90**	**44**	**22**	**-**	**16**	**6**	**224**

Legend:

L	= 100% study materials	+ 0% classroom teaching
ST and E	= 50% study materials	+ 50% classroom teaching
P	= 0% study materials	+ 100% classroom teaching

Appendix B

Module Catalogue

for the master's degree study programme in
Applied Automation (part-time combined studies)
of the Faculty of Engineering and Mathematics

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As of: 13 July 2017

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Drive Systems and Drive Controls					AA
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5005	150	6	2nd or 3rd sem.	annual summer semester	1 sem.

	Course:	Planned group sizes	Scope		actual contact time / classroom teaching		Self-study	
1	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	51	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

After successful completion of the course, students will be able to derive and describe the dynamic behaviour of electrical machines in addition to the steady-state behaviour. The students can explain the principles of controlling three-phase electrical machines. In addition, the students have gained an understanding of the operating point selection for electrical machines and can specify and evaluate reference variables for drive control. In small groups, the students gain initial experience in the design and implementation of a current control system for a three-phase motor using standard simulation software.

3 Contents:

1. Control models
1.1. Synchronous machine
1.2. Asynchronous machine
2. Control models
2.1. Power converter circuits
2.1. Pulse width modulation
2.2. Regular Sampling
2.3. Dead time for digital controls
3. Control method for converter-fed synchronous machines
3.1. Field-oriented control
3.2. Operating point selection for SPMSM (Surface Permanent Magnet Synchronous Motor) and IPMSM (Interior Permanent Magnet Synchronous Motor)
4. Control method for converter-fed asynchronous machines
4.1. Field-oriented control
4.2. Direct torque control (DTC)

4 Forms of teaching:

Learning units for self-study, classroom events in the form of exercises and practicals

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Written examination or oral examination

7 Prerequisite for the award of credit points:

Module examination pass and course assessment

8 Application of the module (in the following study programmes)

Applied Automation (part-time combined studies) (M.Eng.); Industrial Engineering and Management (part-time combined studies) (M.Eng.);

9 Importance of the grade for the final grade:

Percentage based on the sum of credits of the graded modules according to RPO- MA §32

10	Module Coordinator: Prof. Dr. Michael Leuer
11	Other information: -

Image-Based Automation Technology					BAT
Identification number: 5010	Workload: 150	Credits: 6	Study semester: 1st, 2nd or 3rd sem.	Frequency of the offer annual winter semester	Duration: 1 sem.

1	Course:	Planned group sizes	Scope		actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	51	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2	Learning outcomes/competences: Upon successful completion of the module, students will be able to: • explain the basic concepts of imaging systems for use as sensors in automation. • select the appropriate imaging systems for different questions. • assess the usability of the systems in the respective environment. • independently solve problems from the field of imaging automation by selecting software and hardware concepts, among others. • demonstrate basic knowledge of the programming of typical industrially used image processing systems and distinguish between them.
3	Contents: Physical/optical basics of imaging sensor technology Sensor types for automation 2- and 3-dimensional data acquisition for automation Lighting concepts (structure, wavelength) Presentation of the different areas of application (measuring, testing, characterisation, etc.) Basics of coding (creation, reading, verification) Track and trace for automation according to international standards
4	Forms of teaching: Learning units for self-study, classroom events in the form of exercises with project tasks and internships
5	Participation requirements: Formal: - Content: -
6	Forms of assessment: Written or oral examination or performance or combination examination
7	Prerequisite for the award of credit points: Module examination pass and course assessment
8	Application of the module (in the following study programmes) Applied Automation (part-time combined studies) (M.Eng.);
9	Importance of the grade for the final grade: percentage based on the sum of credits of the graded modules according to RPO- MA §32
10	Module Coordinator: Prof. Dr. rer. nat. Marc-Oliver Schierenberg
11	Other information: Literature will be announced at the beginning of the course.

Data Management / Big Data Analytics					BDA
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5011	150	6	1st, 2nd or 3rd sem.	each semester	1 sem.

1	Course:	Planned group sizes	Scope		actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	59	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

The students master the basic handling of NoSQL databases.
Students are able to access internal and external data sources.
Students will be able to describe numerical data by statistical parameters and visualise them in a common way.
Students are able to analyse large amounts of data both in a targeted and exploratory way, with a diverse range of methods from the field of statistics and machine learning at their disposal.
Students will be able to understand the basic procedure for analysing very large data sets on Hadoop clusters.

3 Contents:

Introduction and general overview ("Small Data" vs. "Big Data")
NoSQL database systems
Opening up data sources
Basics of programming with Python (which is used in the exercises for practical data analysis)
Basics of descriptive statistics Visualisation of data
Correlation analysis and regression
Time series analysis
Basics of machine learning
Pre-processing of data (e.g. dimension reduction)
Unsupervised learning (e.g. clustering)
Supervised learning I: Classification (e.g. via support vector machines)
Supervised learning II: Learning of arbitrary input-output correlations (e.g. with artificial neural networks)
Entry into large-scale data analysis with Hadoop

4 Forms of teaching:

Learning units for self-study, classroom sessions in the form of exercises

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Written examination or oral examination

7 Prerequisite for the award of credit points:

Module examination pass

8 Application of the module (in the following study programmes)

Applied Automation (part-time combined studies) (M.Eng.); Industrial Engineering and Management (part-time combined studies) (M.Eng.);

9 Importance of the grade for the final grade:

Percentage based on the sum of credits of the graded modules according to RPO- BA §32

10 Module Coordinator:

	Prof. Dr.-Ing. Wolfram Schenck
11	Other information: -

Digital Signal Processing and Controls					DSR
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5006	150	6	1st, 2nd or 3rd sem.	annual winter semester	1 sem.

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	51	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

After successful completion of the module, students can reproduce basic mathematical knowledge and apply functional transformations for the various forms of representation of discrete signals and systems.
They are able to handle and evaluate the basic procedures of digital signal processing (window techniques, filters, correlation, ...).
The students can apply the knowledge from digital signal processing to design and optimise digital control loops and to describe them in the time or frequency domain.

3 Contents:

1. Digital signal processing
   - Discrete signals, signal sampling, discrete Fourier transform and Fourier analysis, window functions, fast Fourier transform, discrete convolution.
   - Discrete random signals, power density, correlation, short time spectra, power of discrete signals, random signals in linear systems, white and coloured noise.
   - Sampling, discrete Fourier transform and filtering of two-dimensional signals.
   - Discrete systems difference equation, z-transform and z-transfer function, stability of discrete systems, digital filters.
   - Bilinear transformation, transfer functions and recursion formulas of digital filters (IIR), cascading for the realisation of higher order digital filters. Properties and design of non-recursive digital filters (FIR).
   - Selected applications, runtime measurement, system identification. Principle of pattern recognition, signal preprocessing, feature extraction, pattern vectors, non-parametric and parametric classifiers.
2. Digital control
   - Principle structure of digital control loops; sampling process: technical realisation and mathematical description by sample-and-hold element; difference equation
   - z-transform, z-transfer function, discrete convolution; connections between Laplace and z-transform; pole zeros and stability; Shannon's sampling theorem.
   - Digital filters, too: Reference to analogue filters and frequency response representation
   - Procedure for determining the z-transfer function, analytically (exact and approximate), experimentally.
   - Digital control design: digital PID controller, quasi-continuous and discrete design; dead-beat controller; principle of predictive control.
   - Tool-supported design and commissioning of digital controls for an application example (e.g. loading bridge, three-tank system).

4 Forms of teaching:

Learning units for self-study, classroom events in the form of exercises and practicals

5 Participation requirements:

	Formal:	-
	Content:	-
6	Forms of assessment: Written exam or combination exam (term paper with presentation and oral exam)	
7	Prerequisite for the award of credit points: Module examination pass and course assessment	
8	Application of the module (in the following study programmes) Applied Automation (part-time combined studies) (M.Eng.);	
9	Importance of the grade for the final grade: Percentage based on the sum of credits of the graded modules according to RPO- MA §32	
10	Module Coordinator: Prof. Dr. Michael Leuer	
11	Other information: Required literature (in addition to the basic literature) will be announced each semester.	

Embedded Systems and Software Engineering					ESS
Identification number: 5001	Workload: 150	Credits: 6	Study semester: 1st, 2nd or 3rd sem.	Frequency of the offer annual summer semester	Duration: 1 sem.

	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
1	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	59	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

The students can select and apply the tools that support the design process for embedded systems for the solution of automation tasks.

They can analyse given tasks and design suitable embedded systems for this, create a suitable software concept for it and select the necessary tools and test environments.

3 Contents:

1. Embedded Systems
   - Definition
   - Embedded processors
   - Periphery
   - Real-time behaviour
   - Programme implementation: Booting, cross-compiling, linking, loading, remote debugging
   - Programming with scarce resources, interrupt programming, processor-specific non-standard extensions of high-level languages
   - Operating system cores kernel: Process management, scheduling, process communication, hardware abstraction
2. Software programming models
   - Model-based system development
   - The structure diagrams of SysML
   - Tools for model-based development
3. Programming embedded systems using the example of simple mechatronic applications with the Raspberry Pi

4 Forms of teaching:

Learning units for self-study, classroom sessions in the form of exercises

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Written exam or combination exam (term paper with presentation and oral exam)

7 Prerequisite for the award of credit points:

Module examination pass

8 Application of the module (in the following study programmes)

Applied Automation (part-time combined studies) (M.Eng.);

9 Importance of the grade for the final grade:

Percentage based on the sum of credits of the graded modules according to RPO- MA §32

10 Module Coordinator:

N. N.

11 Other information:

	Required literature (in addition to the textbooks) will be announced each semester.

Intellectual Property and Competition Law					GRW
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5007	150	6	1st, 2nd or 3rd sem.	each semester	1 sem.

	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
1	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	59	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2	Learning outcomes/competences:	
	After successful completion of the course, students will be able to understand and apply the basics of patent, utility model and trade mark law, they know the origins, contents and legal effects of patents, designs and trade marks and can analyse individual practical cases, they can evaluate the (negative) prohibition rights in the case of patent, design and trademark infringements and the (positive) possibilities of exploitation of industrial property rights, in particular through licensing and understand the complementary protection under competition law against imitation. They will be able to classify and evaluate various methods (IP right infringements) to counteract product and brand piracy. In addition, they can develop protection concepts independently or as part of a team, and implement (apply) them in the company.	
3	Contents:	
	Patent, utility model and employee invention law, trade mark law, European and international agreements on intellectual property, unfair competition law (supplementary competition law protection against imitation), licensing contract law. Effects of product piracy and protective measures, Development of effective protection concepts and implementation in the company.	
4	Forms of teaching:	
	Learning units for self-study, classroom sessions in the form of exercises	
5	Participation requirements:	
	Formal:	-
	Content:	-
6	Forms of assessment:	
	Written or oral examination or term paper	
7	Prerequisite for the award of credit points:	
	Module examination pass	
8	Application of the module (in the following study programmes)	
	Applied Automation (part-time combined studies) (M.Eng.); Industrial Engineering and Management (part-time combined studies) (M.Eng.);	
9	Importance of the grade for the final grade:	
	Percentage based on the sum of credits of the graded modules according to RPO- MA §32	
10	Module Coordinator:	
	Prof. Dr. Brunhilde Steckler	
11	Other information:	
	Benkard, Patentgesetz, 11. Auflage München 2015. Berlit, Markenrecht, 10. Auflage München 2015. Eckhardt/Klett (Hrsg.), Wettbewerbsrecht, Gewerblicher Rechtsschutz und Urheberrecht (Vorschriftensammlung), jeweils aktuelle Auflage. OR: Beck-Texte im dtv (PatentR, DesignR, MarkenR etc.). Eisenmann/Jautz, Grundriss Gewerblicher Rechtsschutz und Urheberrecht, 10. Auf-	

	lage 2015. Gausemeier/Glatz/Lindemann, Präventiver Produktschutz, München 2012. Götting, Gewerblicher Rechtsschutz (Patent-, Gebrauchsmuster-, Design- und Markenrecht, 10. Auflage 2014. Hering, Gewerblicher Rechtsschutz für Ingenieure, 2014. Haedicke (Hrsg.), Patentrecht, 3. Auflage 2015. Nordemann, Wettbewerbsrecht, Markenrecht, 11. Auflage, Baden Baden 2012.

Handling Technology and Robotics					HR
Identification number: 5009	Workload: 150	Credits: 6	Study semester: 1st, 2nd or 3rd sem.	Frequency of the offer annual winter semester	Duration: 1 sem.

	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
1	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	51	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

The students can analyse the problems from the field of handling technology, propose suitable solutions and design them constructively.
They can select a suitable robot for a handling task, equip it with the necessary peripherals and gripping technology and create the system layout.
They can implement the presented algorithms for coordinate transformation and master the practical aspects of programming a robotic system.

3 Contents:

1. Manufacturing automation
   - Tasks, areas and functions
   - Manually controlled handling machines
   - Programmable handling machines
   - Use of handling equipment in assembly technology
2. Robotics
   - Characteristics of an industrial robot
   - Kinematics of the robot

Kinematic basics
Robot kinematics
Coordinate transformation using homogeneous transformations
The Denavit-Hartenberg transformation
Transformations between robot and world coordinates (backward transf.)

- Robot control and regulation
- Power transmission and drives for robots
- Robot programming
- Industrial robot use and application examples

4 Forms of teaching:

Learning units for self-study, classroom events in the form of exercises and practicals

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Written exam or combination exam (term paper with presentation and oral exam)

7 Prerequisite for the award of credit points:

Module examination pass

8 Application of the module (in the following study programmes)

Applied Automation (part-time combined studies) (M.Eng.);

9 Importance of the grade for the final grade:

Percentage based on the sum of credits of the graded modules according to RPO- MA §32

10 Module Coordinator:

	Prof. Dr. Michael Leuer
11	Other information: Required literature (in addition to the textbooks) will be announced each semester.

Industrial Bus Technology and Communication					IBK
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5008	150	6	1st, 2nd or 3rd sem.	annual summer semester	1 sem.

1	Course:	Planned group sizes	Scope		actual Contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	51	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

The students master the advanced basics of bus communication and bus protocols within a fieldbus system and can assign the requirements for determinism and reliability.
They can assess and select industrial bus systems with regard to their suitability under given boundary conditions and set up and operate bus systems.

3 Contents:

1. Basics
   - Significance of fieldbus systems (classification and overview, OSI model)
   - Physical layer (medium, coding, topology, interfaces, ...)
   - Data link layer (data backup, access procedures)
   - Transmission media (symmetrical, asymmetrical, fibre optics, radio, ...)
   - EMC considerations
   - Real-time requirements / determinism
   - Connection of networks (repeaters, bridges, routers, gateway)
2. Network hierarchies
   - Management / process control / field / sensor-actuator level
   - IoT architectures
3. Industrial bus systems
   - Overview, application and decision-making aids
   - Classic fieldbuses: Profibus, Interbus-S, AS-Interface, Sercos
   - Industrial Ethernet, focus on Ethercat
   - Industrial Wireless
4. Bus systems in the automotive sector
   - CAN
   - FlexRay
   - LIN
5. IoT
   - Pub/Sub instead of Client/Server
   - OPC/UA
   - TSN
   - IoT protocols (MQTT, AMQP)
   - Platforms

Security

Design of communication systems
- Project planning
- Design and system planning
- Performance analysis
- Test
- Diagnosis/Maintenance

4 Forms of teaching:

Learning units for self-study, classroom sessions in the form of exercises

	and practicals	
5	Participation requirements:	
	Formal:	-
	Content:	-
6	Forms of assessment:	
	Written exam or combination exam (term paper with presentation and oral exam)	
7	Prerequisite for the award of credit points:	
	Module examination pass and course assessment	
8	Application of the module (in the following study programmes)	
	Applied Automation (part-time combined studies) (M.Eng.); Industrial Engineering and Management (part-time combined studies) (M.Eng.);	
9	Importance of the grade for the final grade:	
	Percentage based on the sum of credits of the graded modules according to RPO- MA §32	
10	Module Coordinator:	
	N. N.	
11	Other information:	
	Required literature (in addition to the basic literature) will be announced each semester.	

Colloquium					KLQ
Identification number: 5024	Workload: 100	Credits: 4	Study semester: 4th sem.	Frequency of the offer each semester	Duration: 1 sem.

	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
1	Lecture	60 students	0	SCH	0	h	100	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2	Learning outcomes/competences: In the colloquium, the student demonstrates that he or she is able to orally present the results of the master thesis, its subject-related foundations, its interdisciplinary connections and its extra-subject-related references and to justify them independently. Students can critically question the results of their work and are able to assess their significance for practice.	
3	Contents: The colloquium complements the master thesis and is to be assessed independently. Content of the thesis according to the topic Defence of the procedure used in writing the thesis and questions that arose in the context of the work.	
4	Forms of teaching: Oral examination	
5	Participation requirements:	
	Formal:	All modules of the study programme must be successfully completed. The master thesis must be successfully completed.
	Content:	Treatment of the bachelor thesis
6	Forms of assessment: Oral examination for a maximum duration of 75 minutes	
7	Prerequisite for the award of credit points: Passed colloquium	
8	Application of the module (in the following study programmes) Applied Automation (part-time combined studies) (M.Eng.); Industrial Engineering and Management (part-time combined studies) (M.Eng.);	
9	Importance of the grade for the final grade: Percentage based on the sum of credits of the graded modules according to RPO- MA §32	
10	Module Coordinator: N. N.	
11	Other information: -	

Master Thesis					MAR
Identification number: 5023	Workload: 500	Credits: 20	Study semester: 4th sem.	Frequency of the offer each semester	Duration: 1 sem.

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	0	SCH	0	h	500	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2	Learning outcomes/competences:	
	After successful completion of the master thesis, the candidate is able to independently complete a practice-oriented task from his/her special subject area within a specified period of time, both in the subject-specific details and in the interdisciplinary contexts, using scientific methods.	
3	Contents:	
	The master thesis is an independent scientific work from the subject area of the respective study programme with a description and explanation of its solution. It can also be carried out through an empirical investigation or through conceptual or design tasks or through an evaluation of existing sources. A combination of these is possible.	
4	Forms of teaching:	
	Written composition with faculty tutoring	
5	Participation requirements:	
	Formal:	-
	Content:	Coordinated topic from the student’s special subject area
6	Forms of assessment:	
	Master thesis	
7	Prerequisite for the award of credit points:	
	Module examination pass	
8	Application of the module (in the following study programmes)	
	Applied Automation (part-time combined studies) (M.Eng.); Industrial Engineering and Management (part-time combined studies) (M.Eng.);	
9	Importance of the grade for the final grade:	
	percentage based on the sum of credits of the graded modules according to RPO- MA §32	
10	Module Coordinator:	
	N. N.	
11	Other information:	
	Literature will be announced at the beginning of the course.	

Modelling and Simulation of Dynamic Systems					MDS
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5002	150	6	1st, 2nd or 3rd sem.	annual summer semester	1 sem.

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	59	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

Students can model and analyse linear and simple non-linear systems. They can use block diagram-oriented simulation tools. Students can represent dynamic systems and their properties.
They will be able to prepare and interpret simulation results as well as assess numerical problems.

3 Contents:

1. Modelling
   - Introductory examples from automation technology
   - Basic principles of modelling
   - Model validation
   - Structure of mechatronic systems
2. Simulation models
   - Determination of analytical models through theoretical and experimental (identification) modelling
   - Approximation methods in the time domain (determination of characteristic values) and in the frequency domain (continued fraction)
3. Simulation of continuous systems
   - Analogue simulation
   - Digital simulation: Discretisation and integration methods
   - Numerical stability, stiff systems
   - Monte Carlo method
   - MATLAB examples
4. Simulation of discontinuous systems
   - System modelling, basic principles of probability theory
   - Model classes and realisation
   - Replacement problems with uncertain / certain expectations
   - MATLAB examples

4 Forms of teaching:

Learning units for self-study, classroom events in the form of exercises and practicals

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Written exam or combination exam (term paper with presentation and oral exam)

7 Prerequisite for the award of credit points:

Module examination pass and course assessment

8 Application of the module (in the following study programmes)

Applied Automation (part-time combined studies) (M.Eng.);

9 Importance of the grade for the final grade:

Percentage based on the sum of credits of the graded modules according to RPO-

	MA §32
10	Module Coordinator: Prof. Dr. Michael Leuer
11	Other information: Required literature (in addition to the textbooks) will be announced each semester.

Technology and Innovation Management					INM
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5004	150	6	1st, 2nd or 3rd sem.	each semester	1 sem.

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	59	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

Upon completion of the course, students will be able to

- develop innovations with the help of known methods of technology and innovation management and to implement them in relation to the application.
- present the process from strategic orientation, through the generation of innovations, to the selection of suitable projects and finally to their implementation in products, processes or services, as well as to classify them in the corporate structures and processes.
- recognise the different requirements of companies for innovations and technologies in the different countries and to take them into account in the execution.
- transfer their acquired understanding of innovation management in processes of multi-national corporations and internationally operating medium-sized companies.
- assess the differences and interdependencies between technology development, management and marketing and to define the prerequisites for the internal organisational design of change processes.

3 Contents:

Basics of the subject area (innovation and technology concepts, idea generation and evaluation, conditions for innovations, technology life cycles, etc.)
Instruments of strategic and operational innovation management (technology matrix, technology portfolio, merging market and technology portfolio, etc.)
Carrying out market-oriented technology analyses and developing market- and customer-oriented technology and product strategies
Deriving opportunities and risks from the environmental analysis (early technology recognition, technology forecasts, competitor analysis) and identifying the strengths and weaknesses of one's own company (R&D assessment, resources, technological capability)
Influence of technologies on new product development
Application of the tools to concrete company examples

Contents overview:

- Introduction – How do new ideas arise?
- Conceptual basics – From technical invention to market-driven innovation
- Creating orientation – Defining strategic fields of innovation
- Developing ideas – Collecting and generating ideas
- Evaluating + selecting ideas – Recognising "big ideas" and avoiding flops
- Implementing ideas – Applied change management
- Marketing ideas – Innovation is when the market rejoices
- Creating framework conditions – Balancing innovation and routine

4 Forms of teaching:

	Learning units for self-study, classroom sessions in the form of exercises	
5	Participation requirements:	
	Formal:	-
	Content:	-
6	Forms of assessment:	
	Written or oral examination or presentation with paper	
7	Prerequisite for the award of credit points:	
	Module examination pass	
8	Application of the module (in the following study programmes)	
	Applied Automation (part-time combined studies) (M.Eng.); Industrial Engineering and Management (part-time combined studies) (M.Eng.);	
9	Importance of the grade for the final grade:	
	Percentage based on the sum of credits of the graded modules according to RPO- MA §32	
10	Module Coordinator:	
	Prof. Dr.-Ing. Prof. h.c. Lothar Budde	
11	Other information:	
	-	

Distributed Automation Systems					VA
Identification number: 5003	Workload: 150	Credits: 6	Study semester: 1st, 2nd or 3rd sem.	Frequency of the offer annual winter semester	Duration: 1 sem.

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	51	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2	**Learning outcomes/competences:** After successful completion of the course, the students are able to independently optimise in-process data acquisition in the manufacturing process depending on the degree of cross-linking. They know suitable measures to discover and use time optimisation potentials in complex dependencies of a manufacturing process. A deep understanding of the interrelationships between goods transport systems (transfer systems) and automatic processing stations (e.g. robot islands) is conveyed so that students are able to connect complex data transfer systems (PDA or MDA). Knowledge of fault management enables them to minimise plant downtimes with diagnostic and prognostic means. Special emphasis is placed on decentralised and BUS-networked safety technology, which enables students to very effectively integrate UVV-compliant systems into complex safety systems.
3	**Contents:** Linking decentralised automation components Design methods for global automation systems Higher-level integration of shared transfer systems and logistics units (stacking gantries; robots) PDA and MDA in the production process; parts tracking in cycle lines with decentralised automation Central error management with decentralised recording Decentralised networked safety technology (safety bus systems)
4	**Forms of teaching:** Learning units for self-study, classroom events in the form of exercises and practicals
5	**Participation requirements:** Formal: - Content: -
6	**Forms of assessment:** Written examination or oral examination
7	**Prerequisite for the award of credit points:** Module examination pass
8	**Application of the module (in the following study programmes)** Applied Automation (part-time combined studies) (M.Eng.); Industrial Engineering and Management (part-time combined studies) (M.Eng.);
9	**Importance of the grade for the final grade:** Percentage based on the sum of credits of the graded modules according to RPO- MA §32
10	**Module Coordinator:** Prof. Dr.-Ing. Thomas Freund