Appendix B: Module catalogue

for the study programme Engineering Computer Sciences B.Eng.

*Translations of these module descriptions are currently not available.

Algorithms and Data Structures					AUD
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1001	150 h	5	2nd sem.	Annual (Summer)	1 sem.

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	2	SCH	30	h	45	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:

Students:

- are familiar with the possibilities of formal description of algorithms and discuss interface agreements as a basis for the reusability of implemented functions.
- are able to name basic search and sorting algorithms as well as fast sorting algorithms, write them down as pseudo code and explain them.
- programme basic algorithms as functions in a scripting language (e.g. Python) and apply the implemented algorithms to given problems.
- write programme scripts for the numerical evaluation of the algorithm runtime and test their self-implemented algorithms with regard to their runtime as a function of the problem size.
- determine and compare the runtime complexity (efficiency) of different algorithms by analysing the algorithm structure and can thus classify the previously numerically determined runtime behaviour into runtime classes.
- develop and implement backtracking algorithms and fast sorting methods in a scripting language.
- implement their own data structures and data types and test them within the framework of given problems.

3 Contents:

- Basics and terms for the formal description of algorithms
- Formalisation of interface agreements (burdens, obligations, agreement on data formats, agreement on behaviour in case of rules and errors)
- hardware-independent evaluation of the complexity of algorithms (in particular runtime complexity, memory complexity, concept of the register machine [random access machine], O-notation)
- Simple search and sorting algorithms
- Divide-and-conquer strategies, backtracking problems
- Comparison of iterative and recursive programming methods for algorithm implementation
- Fast sorting algorithms
- Abstract and concrete data types
- Graphs and trees
- Hashing

4 Forms of teaching:

	Lecture, sem. lessons and programming exercises	
5	Participation requirements:	
	Formal:	None
	Content:	Basic programming knowledge
6	Forms of assessment: Written examination, combination 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) Engineering Computer Sciences B.Eng.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module Coordinator: Prof. Dr. rer. nat. Axel Schneider	
11	Other information: Literature will be announced at the beginning of the course.	
12	Language: German	

Assistance Systems					ASY
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3349	150 h	5	6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Sem. lessons	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	46	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	1.5	SCH	24	h	0	h

2 Learning outcomes/competences:

- The students know the basics of human-machine systems.
- They explain the design rules of ergonomic human-machine interfaces.
- They know the basics of robotics both in the field of robot manipulators and in the field of mobile robotics.
- They calculate kinematic chains for robot manipulators and motion kinematics for mobile robots.
- They compare robotics applications from the fields of industry, service and care, especially from the point of view of interaction between assistive robots and human operators/users.
- They know the basis of "Computer Vision" and can explain simple algorithms for three-dimensional object recognition; they apply ready-made software implementations of such algorithms to simple visual scenes.
- They know the basics of computer graphics, especially for the presentation of three-dimensional scenes and objects; they can use a 3D graphics API to programme the visualisation of simple 3D scenes.
- They explain the basics of augmented and virtual reality.
- They will implement the representation of 3D objects in a virtual reality environment and the representation of 2D and 3D objects in an augmented reality setup.
- They explain the basics of the voice control of technical systems.

3 Contents:

Human-machine systems:

- Human models
- Ergonomic design
- Design rules of human-machine interfaces

Robotics Basics:

- Robot manipulators (kinematics, elastic drives and manipulators)
- Mobile robotics (kinematics, sensor technology)
- Robotics applications (industrial robots, service and care robots)

	Computer Vision: • Principles • Three-dimensional object recognition • Computer graphics • Basics of 3D representation • Augmented Reality • Virtual Reality Voice control of technical systems: • Basics 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: In-depth computer science knowledge Knowledge of machine learning incl. speech and image recognition Module "HMI and User Interfaces"
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) Digital Technologies (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: N. N.
11	Other information:
12	Language: German

Automation Technology					AT
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1015	150 h	5	3rd sem.	Annual (Winter)	1 sem.

1	Course:	Planned group sizes	Scope		actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

Students:

- understand the principles of automation technology and are able to name the aims of automation technology.
- distinguish between product automation and plant automation.
- create discrete event models using deterministic and non-deterministic automata and Petri Nets.
- analyse discrete event systems.
- design feedforward controllers on the basis of deterministic automata.
- implement sequential controls and test them on a real-world system.

3 Contents:

- Basic principles and objectives of automation technology
- Product automation and plant automation
- Introduction to programmable logic control (PLC)
- Engineering view of systems, processes and signals
- Types of control systems
- Solution of automation tasks
- Description of discrete systems by deterministic and non-deterministic automata and Petri Nets.
- Analysis of deterministic and nondeterministic automata and Petri Nets.
- Controller design and implementation of the control law e.g. by means of sequential control.

4 Forms of teaching:

Lecture with accompanying seminar exercises and practicals

5 Participation requirements:

Formal:	None
Content:	Modules: 1147 Mathematics A; 1153 Mathematics B; 1158 Mathematics C

6 Forms of assessment:

Written or oral examination; in each case with preliminary examination performance

7 Prerequisite for the award of credit points:

Module examination pass with preliminary examination

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

Engineering Computer Sciences B.Eng.

9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr.-Ing. Martin Kohlhase
11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

Bachelor Thesis					BA
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1291	360 h	12	6thor 7th sem.	each semester	12 weeks

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	0	SCH	0	h	360	h
	Sem. lessons	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:	
	With the bachelor thesis, each candidate demonstrates that he/she is able to complete a practice-oriented task from his/her subject area within a specified period of time, both in its subject-specific details and in the interdisciplinary contexts, working independently and according to scientific methods.	
3	Contents:	
	The bachelor thesis is usually an independent investigation with an engineering science or engineering technology task. It should deal with the subject matter in detailed descriptions and explanations and be prepared as a written paper.	
4	Forms of teaching:	
5	Participation requirements:	
	Formal:	None
	Content:	Coordinated topic from the student's special subject area
6	Forms of assessment:	
7	Prerequisite for the award of credit points:	
8	Application of the module (in the following study programmes)	
	Biotechnology and Instrumentation Engineering B.Sc., Electrical Engineering B.Eng., Engineering Computer Sciences B.Eng., Mechanical Engineering B.Eng., Mechatronics B.Sc., Renewable Energies B.Eng. and Industrial Engineering and Management B.Sc.	
9	Importance of the grade for the final grade:	
	according to BRPO	
10	Module Coordinator:	
	N.N.	
11	Other information:	
	Literature will be announced at the beginning of the course.	
12	Language:	
	German	

Operating Systems					BS
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1023	150 h	5	6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

- The students know the basic tasks and basic architectures of operating systems.
- They have mastered the operation of unixoid operating systems at the command line.
- They can explain how processors must provide hardware support for many tasks of modern operating systems.
- They can explain thread and process management and scheduling.
- They compare and evaluate synchronisation mechanisms and apply them in a targeted and measured way to avoid race conditions.
- They analyse situations of deadlock.
- They illustrate how the file management and the input/output management are realised in unixoid operating systems. They master basic system calls, e.g. for process handling, and apply them in programming close to the operating system.
- They create programmes that are close to the operating system, e.g. a simple shell. This includes the creative application of the knowledge acquired in the module to openly formulated problems.

3 Contents:

- General introduction to operating systems (tasks, basic architectures, history)
- Practical handling of Linux
- Necessary hardware support in processors for modern operating systems
- Process management and scheduling (incl. multi-threading)
- Memory management (including page management and virtual memory)
- Synchronisation mechanisms (from atomic operations to semaphores)
- Deadlocks and strategies for resolving them
- File management
- Input/output management

4 Forms of teaching:

Lecture, seminar-style teaching with exercises, and practical course with implementation of programming projects related to operating systems (with a short paper or presentation)

5 Participation requirements:

	Formal:	None
	Content:	• Basic computer science and programming skills (especially in C) • Basic knowledge of computer architectures Modules: 1105 Computer Science 1; 1109 Computer Science 2; 1231 Computer Architectures;
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) Engineering Computer Sciences B.Eng. and Industrial Engineering and Management B.Sc.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module Coordinator: Prof. Dr.-Ing. Wolfram Schenck	
11	Other information: Literature will be announced at the beginning of the course.	
12	Language: German	

Business Administration					BW
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1024	150 h	5	3rd or 5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	3	SCH	45	h	67.5	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	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: The students know the basic organisational and legal structures of companies and are familiar with the optimisation tasks in selected entrepreneurial functional areas as well as with the basic principles and success criteria of economic action in order to be able to classify their engineering activities in a business management context and to evaluate the economic consequences of their activities. The students master methods and tools for problem solving in selected corporate functional areas. They can apply business management instruments and calculation methods in a target-oriented manner and assess their effects.
3	Contents: • Basic concepts of business administration / basic principles of economic action • Overview of the entrepreneurial functional areas of the goods economy, financial economy and information economy level • Corporate goals and corporate key figures / key figure systems • Basic concepts of private and commercial law • Forms of corporate law
4	Forms of teaching: Lecture, sem. lessons with case studies / case studies / exercises
5	Participation requirements: Formal: Content:
6	Forms of assessment: Written examination, combination examination, performance 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) Electrical Engineering B.Eng., Engineering Computer Sciences B.Eng., Mechanical Engineering B.Eng. and Renewable Energies B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr. rer. oec. Klaus Rüdiger
11	Other information:

	Literature will be announced at the beginning of the course.
12	Language: German

Digital Image Processing and Pattern Matching					BVM
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1028	150 h	5	4th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

Students have basic technical knowledge of image acquisition, grey value operations, local filter operations (convolutions) as well as simple segmentation and classification procedures and apply these in a well-founded manner. They independently solve simple problems and applications in image processing and pattern recognition. In doing so, they select suitable procedures, analyse the advantages and disadvantages of the procedures, apply them correctly and develop appropriate programs in suitable programming languages, which they then test on practical examples. Simple problems from the application are implemented and solved by the students independently and creatively. They plan, structure and develop their own simple procedures, programme them and justify, test and evaluate them. Students organise themselves effectively in working groups and take responsibility for themselves and the group.

They assess their own strengths and weaknesses appropriately and develop a picture of their own development beyond their studies.

3 Contents:

- Basic principle of image processing and pattern recognition, applications.
- Image capture: Rasterisation, quantisation
- Design of camera, lens, lighting for the application
- Elementary image processing: Grey value histogram, dot operators.
- Local operations with greyscale images: Smoothing operators, edge operators, sharpness operators.
- Simple segmentation algorithms.
- Feature extraction and simple classification procedures.
- Applications of image processing/pattern recognition using practical examples

Lab practicals:

- Image acquisition with different image acquisition units
- Programming of image processing operators according to the content of the event by means of suitable software
- Planning, structuring, developing, programming, testing and evaluating simple own procedures for solving application-oriented problems

Image processing and/or pattern recognition tasks

4 Forms of teaching:

Lecture, sem. lessons, group work within the framework of the practical course

5 Participation requirements:

Formal:	None
Content:	C programming skills

6	Forms of assessment: Written 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) Engineering Computer Sciences B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr. rer. nat. Antje Ohlhoff
11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

Cluster Computing					CLC
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3344	150 h	5	3rd sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Sem. lessons	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	54	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

- Students explain the theoretical foundations of parallel computing (parallel computer architectures, Amdahl's law, race conditions, design patterns for parallel computing, etc.).
- They design and implement distributed applications using MPI and OpenMP.
- They explain the concept of Hadoop.
- They implement simple data analyses on a Hadoop cluster.
- They know the theoretical basics of cloud computing and compare the possibilities of different commercial platforms.
- They implement data analysis workflows in the cloud.

3 Contents:

- Theoretical foundations of parallel computing (parallel computing architectures, Amdahl's law, race conditions, design patterns for parallel computing, etc.)
- Distributed computing with MPI
- Parallel computing on individual SMP systems (e.g. with OpenMP)
- Parallel computing on Hadoop clusters (Map-Reduce, etc.)
- Cloud computing in theory and practice

4 Forms of teaching:

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

5 Participation requirements:

Formal:	
Content:	• Modules “Foundations of Computer Science” and “Object-Oriented Programming” • Basic knowledge of databases

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)

Digital Technologies (work-integrated) B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10 Module Coordinator:

N. N.

11	Other information:
12	Language: German

Data Mining					DM
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3341	150 h	5	4th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Sem. lessons	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	54	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

- The students explain the history and basis of data mining and establish the relationship to its practical application possibilities.
- They apply appropriate procedures to visualise both small and large data sets and the interrelationships within them in an instructive way ("Visual Analytics").
- They use correlation analysis and regression to detect relationships between data series in multidimensional data sets.
- They are proficient in common dimensional reduction techniques.
- They can find clusters of related data points in multi-dimensional data sets and assess their quality.
- They detect common patterns in data sets and use graph-based methods.
- They have basic knowledge of time series analysis and apply simple procedures from this area in a targeted manner.
- They have a comprehensive overview of data mining methods and can assess which methods should be used in which application scenarios.
- They design data mining workflows.

3 Contents:

- Basics of data mining
- Visualisation of data (especially also for the visualisation of very large amounts of data; "Visual Analytics")
- Correlation analysis and regression
- Dimension reduction
- Clustering methods
- Frequent pattern mining
- Graph-based methods
- Basics of time series analysis
- Data mining workflows

4 Forms of teaching:

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

5 Participation requirements:

Formal:	
Content:	• Content of the "Mathematics" and "Statistics" modules • Advanced programming skills in Python

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) Digital Technologies (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: N. N.
11	Other information:
12	Language: German

Database Applications					DBA
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1041	150 h	5	6th sem.	Annual Summer	1 sem.

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

- The students have basic knowledge of the advantages and possibilities of the structure and use of relational databases, and can explain and apply this knowledge. On the basis of this knowledge, they are able to independently design real-world objects as a hierarchical database model and to map them practically in an SQL database.
- Students insert new data into a relational database, perform complex queries of data according to given criteria and join tables according to chosen integrity rules.
- The students apply techniques of web server programming (e.g. JakartaEE) and plan applications in group work according to the Model-View-Controller-Software-Pattern to modify data of a database and to insert and query it via a web interface (Javascript Framework).
- Students will be able to compare, combine and evaluate specific methods and techniques for databaseapplications and will be able to plan and develop database transactions.
- The students will learn about the advantages of object-based, distributed database applications and be able to classify them.

3 Contents:

- Knowledge of the architecture, functioning and use of database systems,
- Basic concepts of relational and object-relational data models,
- Introduction to SQL (Structured Query Language),
- Use of SQL to create, delete, modify and query data records,
- Introduction to programming dynamic web pages (e.g. JakartaEE, JSF, Primefaces),
- Connection of databases in web applications using suitable examples.

4 Forms of teaching:

Lecture, sem. lessons, project and group work within the framework of the practical

5 Participation requirements:

Formal:	None
Content:	Good knowledge in the field of object-oriented programming, general algorithms and data structures (generic programming) Modules: 1001 Algorithms and Data Structures; 1105 Computer Science 1; 1109 Computer Science 2; 1245 Software Engineering

6 Forms of assessment:

Written examination, combination 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) Engineering Computer Sciences (B.Eng.) and Mechatronics (B.Sc.)
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr.-Ing. Lutz Grünwoldt
11	Other information: Literature will be announced at the beginning of the course. A script will be provided.
12	Language: German

Introduction to Engineering Computer Sciences					EII
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1052	150 h	5	1st sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	2	SCH	30	h	45	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:

Students:

- gain an overview of the special subject area of engineering computer science.
- know the areas of expertise of an IT engineer in research, development and industry.
- understand the structure of the study of engineering computer science and allocate time to different aspects of their studies in a structured way.
- learn the basics of scientific work
- research and evaluate sources of information and thus also the quality of their research results in the field of technological issues.
- prepare and present research results on information technology and engineering topics in a structured manner.
- use current text typesetting systems to create specialized scientific texts.

3 Contents:

- Engineering computer science compared to other computer science disciplines
- Overview of the day-to-day work of an engineering IT specialist
- Presentation of research and development projects as part of internal and external excursions
- Research and work with scientific sources in engineering
- Processing and presentation of work results
- Structure and writing of scientific papers
- Introduction to professional typesetting systems
- Project and time management in studies and at work

4 Forms of teaching:

Lecture and seminar teaching

5 Participation requirements:

Formal:	None
Content:	None

6 Forms of assessment:

Term paper or combination examination

7 Prerequisite for the award of credit points:

Module examination pass

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

Engineering Computer Sciences B.Eng.

9	Importance of the grade for the final grade:
10	Module Coordinator: Prof. Dr. rer. nat. Axel Schneider
11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

Embedded Systems					ESYS
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1079	150	5	6th semester	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

Students:

- name and explain the different hardware concepts on which common embedded systems are based.
- explain the underlying hardware technologies, name advantages and disadvantages and evaluate the applicability for various practical problems.
- implement combinatorial and sequential function blocks in a synthesis language (e.g. VHDL) and use common toolchains to bring the synthesised functions to a target hardware (e.g. FPGA).
- develop a complex logic component according to specifications based on the previously developed function modules.
- evaluate algorithms with regard to their implementability in hardware or software (hardware/software co-design).
- explain design concepts for the hardware-related processing of discrete and continuous signals.
- distinguish the parallel design of algorithms for the hardware synthesis from conventional programming.
- compare their synthesis results with those of the other students and discuss differences in small groups.

3 Contents:

- Introduction to the topic of embedded systems (reactive, transforming systems, etc.)
- Classification of embedded hardware (microcontrollers, microprocessors, FPGAs, SoCs, etc.)
- Hardware technologies for the implementation of digital logic (SPLDs, CPLDs, FPGAs, ASICs)
- Repetition of combinatorial and sequential logic (pipelining etc.)
- Concepts of reliability, efficiency, hard and soft real time
- Hardware description languages (synthesis languages such as VHDL, VERILOG) compared to programming languages
- Introduction to VHDL
- Implementation of combinatorial and sequential logic components such as adders, multiplexers, automata, etc. in VHDL and their synthesis for an FPGA
- Synchronisation of the communication of asynchronous systems (synchronisation, metastability)
- Implementation of simple bus systems

	- Aspects of hardware/software co-design - Control of mechatronic systems such as robots	
4	Forms of teaching: Lecture, sem. lessons, practical course	
5	Participation requirements:	
	Formal:	None
	Content:	Basic knowledge in the fields of digital technology, programming and computer architectures Modules: 1045 Digital Electronics II; 1070 Digital Electronics I; 1104 Computer Science 1
6	Forms of assessment: Written examination, combination 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) Electrical Engineering B.Eng., Engineering Computer Sciences B.Eng., Mechatronics B.Sc. and Industrial Engineering and Management B.Sc.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module Coordinator: Prof. Dr. rer. nat. Axel Schneider	
11	Other information: Literature will be announced at the beginning of the course.	
12	Language: German	

Building Automation					GAT
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1095	150 h	5	4th or 6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	2	SCH	30	h	45	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:

The students determine the requirements for building automation for residential and non-residential buildings, in particular for the integration of local renewable energy generation, with the help of the specifications from the relevant standards and guidelines and with the help of basic physical models of the components for heating, ventilation and air conditioning. They design basic automations and controls using standard techniques and standard diagrams. They discuss the contributions of such plants to energy efficiency qualitatively and quantitatively. They methodically assess which human-building interfaces are appropriate for the respective application.

3 Contents:

- Definition and structure of building automation
- Possibilities and limits of energy efficiency through smart buildings
- Requirements for human use: comfort, pollutants, etc.
- Heating, ventilation, air conditioning: basic devices (also for the use of renewable energies), physical principles, characteristic curves
- Use of sensors and actuators; ubiquitous/pervasive computing
- Control, controller types, optimisation of energy use
- Bus systems, protocols, networking, computer systems, building management systems
- User interfaces, usability
- Accessibility, ambient assisted living, smart homes
- Overarching topics: Standards, guidelines, standard diagrams for planning and documentation

4 Forms of teaching:

Lecture, seminar

5 Participation requirements:

Formal:	None
Content:	Computer Science 1 (1107), Feedback Control Engineering (1235), Fundamentals of Energy Technology (1097), Sensors (1243)

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)

	Engineering Computer Sciences B.Eng. and Renewable Energies B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr. rer. nat. Jörn Loviscach
11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

Gender and Diversity: Success Factors for Companies					GUD
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3135	150 h	5	5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	2	SCH	30	h	45	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:

The students ..

- know the terms, history and differences of gender/gender mainstreaming and diversity/diversity management.
- know legal principles in the context of gender and diversity (e.g. EU Anti-Discrimination Directive, General Equal Treatment Act)
- are sensitised to human heterogeneity in the corporate context.
- independently recognise stereotyping and can develop ideas for possible changes in the business environment.
- are able to independently collect relevant information on established concepts such as gender mainstreaming and diversity management and to assess their relevance for professional practice.
- are familiar with selected theories and approaches in the current discourse on diversity management and, building on this, are able to develop conceptual ideas for the implementation of holistic diversity management in a corporate context.

3 Contents:

- Definitions and delimitation of gender and diversity
- Concepts and approaches to equal opportunities (e.g. diversity management, gender mainstreaming)
- Legal basis and political influences (e.g. EU Anti-Discrimination Directive, General Anti-Discrimination Directive, General Equal Treatment Act (German abbreviation: AGG))
- Subjective and social values, attitudes and prejudices in the context of diversity
- Possible approaches for taking diversity characteristics (e.g. gender and age) into account in selected areas of business (marketing, product development, human resources)
- Concept for the sustainable introduction of holistic diversity management
- Case studies and application examples from business practice

4 Forms of teaching:

Lecture, sem. lessons, presentation, group work, presentation of seminar paper

5 Participation requirements:

Formal:	
Content:	None

6	Forms of assessment: Term paper, 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 Mathematics B.Sc., Biotechnology and Instrumentation Engineering B.Sc., Electrical Engineering B.Eng., Computer Engineering B.Eng., Mechanical Engineering B.Eng., Mechatronics B.Sc., Renewable Energies B.Eng. and Industrial Engineering and Management B.Sc.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr.-Ing. Andrea Kaimann
11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

Business Process Modelling and IT Systems					GPM
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3210	150 h	5	3rd sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	64	h
	Sem. lessons	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	46	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

Students:

- structure and evaluate the specific mode of operation of integrated standard software (ERP software).
- design and model with the help of modern software architectures (e.g. SOA and BPMS) the processes in the company.
- analyse processes and requirements of companies for the use, operation and maintenance of integrated software systems (adaptation options, interfaces to other IT systems, etc.)

3 Contents:

- Process modelling and data modelling using modelling tools such as ARIS
- Evaluation of concepts of integrated data processing
- Drafting reference models for designing the data, process and function models (e.g. Aachen PPS model)
- Analysis of ERP systems (architecture, structuring, database models, HANA)
- Overview of the core modules and applications of ERP systems in the process: e.g. order to cash process)

Application-oriented use cases are used to demonstrate how business processes can be implemented consistently and across software modules.

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:

Term paper, written examination, project work 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)

Digital Logistics (work-integrated) B.Eng., Digital Technologies (work-integrated) B.Eng. and Industrial Engineering and Management (work-integrated) B.Eng.

9 Importance of the grade for the final grade:

	according to BRPO
10	Module Coordinator: Prof. Dr.-Ing. Jörg Nottmeyer
11	Other information: -
12	Language: German

High Performance Computing					HPC
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1006	150 h	5	6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	15	h	22.5	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

In addition to the theoretical basics, the common basic concepts of current architectures and strategies are presented. The internship focuses on practical work within a Beowulf teaching cluster. Students will be able to design and implement parallel algorithms. They will learn about frequently used libraries for parallelisation and know how to use them for given problems and apply them in practice.

Students:

- know the basic concepts of scientific and parallel (high-performance) computing,
- can select suitable parallelisation strategies and apply them,
- are also familiar with the essential characteristics of memory- or directionally-coupled parallel systems and their programming,
- are able to develop parallel algorithms to solve given problems,
- are proficient in the standard Message Passing Interface (MPI) for Distributed Computing,
- can convert given or self-developed parallel algorithms into efficient programs (MPI or OpenMP) on HPC systems,
- can identify and correct errors in an implementation, can compare and assess optimisation options and
- are proficient in the operation of high-performance computers and can adapt their self-written programmes to these and execute them there.

3 Contents:

Many questions in the natural sciences and engineering ultimately boil down to the solution of mathematical problems, such as solving systems of equations or minimising error functionals. For this purpose, parallelisation for distributed and shared memory architectures, such as HPC clusters and multi-core CPUs, is discussed.

	• General Introduction to High Performance Computing [https://hpc.ad.fh-bielefeld.de|HPC] (Tasks, basic architectures, history) • Parallel computer and system architectures for HPC: Modern high-performance CPUs, symmetrical multiprocessor systems (SMPs), parallel computers with distributed memory, and clusters of PCs/workstations • Programming parallel and distributed computer systems • Practical handling of High Performance Computing Clusters Typical HPC applications	
4	Forms of teaching: Lecture, exercise, practical course, self-study	
5	Participation requirements:	
	Formal:	None
	Content:	• Sound computer science and programming skills (especially in C) • Basic knowledge of operating systems Basic knowledge of networks and their architecture • Basic knowledge of mathematics Modules: 1001 Algorithms and Data Structures; 1105 Computer Science 1; 1231 Computer architectures;
6	Forms of assessment: Term paper, combination examination or project work	
7	Prerequisite for the award of credit points: Module examination pass	
8	Application of the module (in the following study programmes) Engineering Computer Sciences B.Eng.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module Coordinator: Prof. Dr. rer. nat. Christian Schröder	
11	Other information: Literature will be announced in the course. Teaching language: German, original English literature	
12	Language: German	

High-Frequency Electronics					HFE
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1101	150 h	5	5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

After completing the module, students will be able to:

- name, calculate and understand all common four-pole parametres for the description of linear components in AC and high-frequency technology,
- select and apply the measurement technique for determining four-pole parameters and evaluate the measurement results produced,
- explain the state of wave matching of linear high-frequency systems and design the necessary system boundary conditions,
- explain components of high-frequency electronics and select them for the specific application

3 Contents:

- Four-pole theory for the description of linear circuits
- Theory of lines
- Wave matching
- Scattering parameters
- The Smith Chart
- Components of high-frequency electronics
- Laboratory practicals in small groups

4 Forms of teaching:

Lecture, sem. lessons, laboratory practicals in small groups.

5 Participation requirements:

Formal:	None
Content:	Mathematics 1 (1146 or 1147) and 2 (1152 or 1153). Electrical Engineering 1 (1071 or 1072) and 2 (1075)

6 Forms of assessment:

Written or oral examination; in each case with preliminary examination performance

7 Prerequisite for the award of credit points:

Module examination pass with preliminary examination

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

Electrical Engineering B.Eng., Engineering Computer Sciences B.Eng. and Mechatronics B.Sc.

9 Importance of the grade for the final grade:

according to BRPO

10 Module Coordinator:

	Prof. Dr.-Ing. Rüdiger Schultheis
11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

IT Security Management									ITSM
Identification number:	Workload:	Credits:	Study semester:			Frequency of the offer:			Duration:
1403	150	5	6th semester			Annual (Summer)			
1	Course:	Planned group sizes:	Scope:			Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	Weekly hours		30	h	45	h
	Sem. lessons	30 students	2	SCH		30	h	45	h
	Exercise	20 students		SCH			h		h
	Practical or seminar	15 students	0	SCH		0	h	0	h
	Supervised self-study	60 students		SCH			h		h

2 Learning outcomes/competences:

- Students are familiar with the basics of modern IT security management in accordance with ISO/IEC 27001,
- Based on the historical conception of modern computer architectures, they recognise corresponding dangers for information security,
- Students know the requirements for an information security management system (ISMS),
- Students are able to assess security concepts and identify vulnerabilities for various scenarios in given examples,
- They design use cases and plan the monitoring of structures worthy of protection in laboratory environments,
- They are familiar with the role and duties of (Chief) Information Security Officers (CISO) within organisations.

3 Contents:

- Basics of security of modern IT systems,
- Potential targets for and types of attack,
- Vulnerability assessment,
- Security engineering,
  - Security concepts (ISO 27001, BSI, CIS, etc.),
  - Construction principles,
  - Risk calculations and risk management,
- Information security life cycle,
  - Internal and external audits,
  - Information Security Management System (ISMS) and mobile infrastructures,
  - Compromised assessments,
  - Security information and event management,
  - Security Operation Center / Cyber Defense Center,
  - Identity and access management / Privileged access management.

4 Forms of teaching:

Lecture, sem. lessons including practical exercises

5 Participation requirements:

Formal:	
Content:	• Basic knowledge of computer science • Basic knowledge of analysis

6 Form 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):

Engineering Computer Sciences B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10	Module coordinator: Prof. Dr.-Ing. Wolfram Schenck
11	Other information: • Eckert, C.: IT-Sicherheit: Konzepte – Verfahren – Protokolle, De Gruyter Oldenbourg; ISBN: 9783110551587, 10. Auflage 2018 • Kersten u.a.: IT-Sicherheitsmanagement nach der neuen ISO 27001 - ISMS - Risiken - Kennziffern – Controls. Springer Vieweg: ISBN 978-3-658-27691-1, 2020 • Müller, K.-R.: Handbuch der Unternehmenssicherheit. Springer Vieweg: ISBN 978-3-658-40572-4, 2022
12	Language:

Computer Science 1					INF1
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1105	150 h	5	1st sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

- Students explain the basics of computer science and computer design.
- They convert number representations between any position systems.
- They can explain the encoding of numbers and strings in the computer.
- They design small algorithms with the help of common tools such as structure diagrams or programme flow charts.
- They know the constructs of the C programming language and large parts of the C standard.
- They define and implement functions and call them in a correctly parameterized form.
- They master structured programming and implement small algorithms in the C programming language, using functions from the C standard library in a correct and purposeful way.
- In particular, they apply functions from the C standard library for reading and writing files.
- They have mastered the operation of an integrated development environment that includes an editor, a compiler, a linker and a debugger.

3 Contents:

- Overview of the basics and history of computer science
- Structure and functioning of a digital computer
- Conversion between number systems (binary, octal, decimal, hexa-decimal)
- Encoding of numbers and strings in the computer
- Designing algorithms (e.g. with structure diagrams and programme flow charts)
- Programming in C
- Important functions from the C standard library
- Reading and writing files with C

4 Forms of teaching:

Lecture, sem. lessons, practical programming tasks within the framework of the practical course

5 Participation requirements:

Formal:	None
Content:	None

6 Forms of assessment:

	Written or oral examination; in each case with preliminary examination performance
7	Prerequisite for the award of credit points: Module examination pass with preliminary examination
8	Application of the module (in the following study programmes) Engineering Computer Sciences B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr.-Ing. Wolfram Schenck
11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

Computer Science 2					INF2
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1109	150 h	5	2nd sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

- Students name the basic theoretical principles of object-oriented programming (OOP).
- They distinguish OOP from other programming paradigms. They create class diagrams with UML (Unified Modeling Language) and translate them into correct C++ code.
- They can explain the central concepts and constructs of the programming language C++ and use polymorphism, templates, operator overloading and exception handling in a purposeful and appropriate way when programming.
- They name the central classes of the C++ standard library and their purpose and apply them in programming.
- They design and implement small C++ programmes on their own and are able to evaluate different implementation approaches comparatively.
- They understand simple design patterns of OOP and use them in C++.
- They implement small applications with graphical user interfaces.

3 Contents:

- Basic concepts of object-oriented programming (OOP) and their implementation in UML (Unified Modeling Language) and C++
- Building elementary class relationships and hierarchies
- Advanced topics in OOP with C++: Polymorphism, overloading of operators, function and class templates, exception handling
- Frequently used classes from the C++ standard library
- Simple OOP design patterns (such as Singleton, Factory or Ob- server)
- Digression: Programming of graphical user interfaces (event-oriented programming with C++)

4 Forms of teaching:

Lecture, sem. lessons, practical programming tasks within the framework of the practical course

5 Participation requirements:

Formal:	None
Content:	Modules: 1105 Computer Science 1;

6 Forms of assessment:

	Written or oral examination; in each case with preliminary examination performance
7	Prerequisite for the award of credit points: Module examination pass with preliminary examination
8	Application of the module (in the following study programmes) Engineering Computer Sciences B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr.-Ing. Wolfram Schenck
11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

Innovation and Project Management					IPM
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3211	150 h	5	3rd/4th/5th/7th sem.	each semester	1 semester

1

Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
Lecture	60 students	2	SCH	0	h	56	h
Sem. lessons	30 students	0	SCH	0	h	0	h
Exercise	20 students	2	SCH	16	h	62	h
Practical or seminar	15 students	0	SCH	0	h	0	h
Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

Students:

- are prepared to lead product development and innovation projects and teams to success in terms of holistic and strategically oriented project management (also including agile methods).
- understand the basics of project management and can use the elementary technical vocabulary.
- can explain the most important instruments of project management.
- are able to lead/manage a project in a given process-organisational project organisation.
- are able to develop and specifically use control options for different project phases (controlling of the degree of completion, cost controlling).
- can explain the specifics of team building and project management.
- can carry out the moderation of team meetings projects.
- know instruments of IT-supported project management.
- can explain the importance of corporate objectives and are able to distinguish between different management cultures.
- can name essential aspects of industrial property protection.

3 Contents:

- Basics of project management (terms/methods/instruments)
- Project phase models and planning systems (project preparation, project planning, project implementation, project completion)
- Agile project management Forms of project organisation
- Innovation and change management, self-management
- Project planning (project structure plan/cost plan/resource plan/schedule)
- Project documentation/ project controlling Risk management
- Special features of use of methods in innovation projects

	(Strategic preparation / initiation, planning, monitoring and control of innovation projects) • Leading project and innovation teams (social structures, special communication situations in projects, real and virtual project work, problem analysis and concepts for action) • Stakeholder management (factors influencing the successful management of projects) • Methods of idea generation (creativity techniques etc.) • Trainings and workshops on selected technical examples • Basic aspects of industrial property protection
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: Term paper, written examination, project work or oral examination
7	Prerequisite for the award of credit points: Module examination pass
8	Application of the module (in the following study programmes) Digital Logistics (work-integrated) B.Eng., Digital Technologies (work-integrated) B.Eng., Mechatronics /Automation (work-integrated) B.Eng., Product Service Engineering work-integrated B.Eng. and Industrial Engineering (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr.-Ing. Michael Fahrig
11	Other information: -
12	Language: German

Integrated Product Development					IP
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1232	150 h	5	4th or 6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	2	SCH	30	h	45	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: The students distinguish between different product development processes and know different development methods and tools. They can select and apply these methods in a targeted manner. They are able to work methodically, systematically and purposefully on a technical problem area and apply guiding rules for methodical development.
3	Contents: Methodical development of products (based on VDI 2206, 2221, 2222, among others) Planning, tasks, specifications/requirements list, development structuring -> Overall function, sub-functions, functional structure, Idea generation/creativity process -> Overview of methods, discursive and intuitive methods, evaluation of alternative solutions, evaluation procedures. Selected development guidelines (e.g. cost-conscious development, design in accordance with stresses)
4	Forms of teaching: Lecture, sem. lessons, practical exercises
5	Participation requirements: Formal: None Content: None
6	Forms of assessment: Written examination, combination 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) Biotechnology and Instrumentation Engineering B.Sc., Engineering Computer Sciences B.Eng., Mechanical Engineering B.Eng. and Mechatronics B.Sc.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr.-Ing. Klaus Dürkopp
11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

Sensors and Actuators					ISS
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1311	150 h	5	6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

In relation to the contents listed below, the students can classify and assess sensors as essential components of mechatronic systems. They can select and configure sensors suitable for mechatronic production processes in a targeted manner, and design and develop sensors relevant for mechatronic products. They confidently apply the necessary means and methods of describing sensor systems as an essential step in overall system design. The students use the basic knowledge of signal processing in the field of sensor technology to design intelligent sensor systems. They analyse trends and current fields of application in the area of modern sensor technology and the associated development methodology.

3 Contents:

Sensors:

Definition of terms, categorisation according to transducer technologies, categorisation according to applications, sensor characterisation (accuracy, resolution, sensitivity, linearity)

Sensor signal chain:

Signal processing and conditioning, design and realisation of analogue filters, ADU/DAU, sampling theorem

Sensor signal processing:

Sensor error correction, discrete-time processing of analogue signals, spectral analysis/FFT, windowing, design and implementation of digital filters

Construction of technical sensor systems:

Integration levels, intelligent sensors, indirect/virtual sensors, aspects of embedded systems (mC, DSP, FPGA), connectivity/network connection

Development methodology and applications

4 Forms of teaching:

Lecture, sem. lessons with computer exercises, practical course

5 Participation requirements:

Formal:	
Content:	Electrical Engineering (1073 and 1076 Mechatronics. 1070 Engineering Computer Sciences, 1070 Industrial Engineering and Management), Electronics (1063 Mechatronics. 1067 and 1069 Engineering Computer Sciences, 1065 Industrial Engineering and Management), Electrical Engineering 2

6 Forms of assessment:

Written examination, combination examination, performance 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) Electrical Engineering B.Eng., Engineering Computer Sciences B.Eng., Mechatronics B.Sc. and Industrial Engineering and Management B.Sc.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr.-Ing. Joachim Waßmuth
11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

International Management/Marketing					IMM
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1115	150 h	5	6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	32	h	43	h
	Sem. lessons	30 students	2	SCH	32	h	43	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 attending the lecture, students will be able to

- name and explain the importance of international market development for the success of a company and the associated special features and tasks of international marketing.
- classify the special features and tasks of international marketing in the context of the knowledge of marketing basics acquired in other courses and identify differences.
- apply the special features and tasks of international marketing to selected practical examples and case studies and independently solve the associated tasks and present the results.
- critically reflect on the special features and tasks of international marketing.
- recapitulate the course content independently and deepen their knowledge through self-study. Ideally, they will form learning groups that last throughout the entire study period.

3 Contents:

Introduction to International Marketing

- Coordination in the context of international market development
- Environmental analysis
- Risk analysis
- Planning marketing objectives
- Market entry decisions
- Marketing instruments in international marketing

4 Forms of teaching:

Lecture, sem. lessons with exercises, case studies/case studies

5 Participation requirements:

Formal:	None
Content:	Knowledge of the contents of the module Marketing (1143) Knowledge of English

6 Forms of assessment:

Written examination

7 Prerequisite for the award of credit points:

	Module examination pass
8	Application of the module (in the following study programmes) Engineering Computer Sciences B.Eng., Mechatronics B.Sc. and Industrial Engineering B.Sc.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr. rer. oec. Klaus Rüdiger
11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

Investment and Financing					FIN
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1118	150 h	5	2nd, 4th or 6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	3	SCH	45	h	67.5	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	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: The students gain knowledge of the methods of investment calculation and of the basic forms of financing in their possibilities and limits. They can assess the importance of rational investment and financing decisions for the success of a company. They are familiar with the various instruments of investment appraisal and can apply them to specific cases and evaluate the calculation results realised with regard to the practical implementation of investment decisions. Students know the basic forms of finance and can classify them. Students can allocate the appropriate forms of financing to different financing occasions. They are able to calculate the financing costs and make justified decisions regarding the suitability of the respective forms of financing.
3	Contents: • Basic concepts of investment and financing • Methods of static investment calculation • Methods of dynamic investment calculation • Forms of external financing • Forms of internal financing
4	Forms of teaching: Lecture, sem. lessons
5	Participation requirements: Formal: Content: Knowledge of the contents of the module General Business Administration (1002 or 1024)
6	Forms of assessment: Written examination, combination examination, performance 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) Engineering Computer Sciences B.Eng., Renewable Energies B.Eng. and Industrial Engineering B.Sc.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr. rer. pol. Hubertus Wameling
11	Other information: Literature will be announced at the beginning of the course.

	Renewable Energies study programme: Elective module
12	Language: German

Colloquium					KOL
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1290	90 h	3	6th or 7th sem.	each semester	

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	0	SCH	0	h	90	h
	Sem. lessons	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:	
	The colloquium is to be assessed as an independent examination. It serves to determine whether the candidate is capable of orally presenting and independently justifying the scientific topic of the bachelor thesis, its subject-related foundations, its interdisciplinary connections and its non-subject-related references, as well as its significance for practical applications.	
3	Contents:	
	- Content of the thesis according to the topic - Disputation on the procedure in the preparation of the thesis and the questions that arose in the context of the thesis	
4	Forms of teaching:	
	Oral examination for the bachelor thesis	
5	Participation requirements:	
	Formal:	None
	Content:	Treatment of the bachelor thesis
6	Forms of assessment:	
	Oral examination	
7	Prerequisite for the award of credit points:	
8	Application of the module (in the following study programmes)	
	Applied Mathematics B.Sc., Biotechnology and Instrumentation Engineering B.Sc., Electrical Engineering B.Eng., Computer Engineering B.Eng., Mechanical Engineering B.Eng., Mechatronics B.Sc., Renewable Energies B.Eng. and Industrial Engineering and Management B.Sc.	
9	Importance of the grade for the final grade:	
	according to BRPO	
10	Module Coordinator:	
	N.N.	
11	Other information:	
	Literature will be announced at the beginning of the course.	
12	Language:	
	German	

Cost and Performance Accounting					KUL
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1130	150 h	5	3rd or 5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	2	SCH	30	h	45	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: Students will be able to show the aims and tasks of cost and performance accounting and explain the traditional basic structure of cost accounting systems, cost type accounting, cost centre accounting and cost unit accounting. They know that the recording and processing of all costs of an enterprise is an indispensable prerequisite for a functioning cost and activity accounting system and master the sub-steps of cost distribution, cost allocation, cost allocation and cost control required within the framework of cost unit accounting. The students can carry out both a unit-related and a time-related cost and performance assessment and weigh up the advantages and disadvantages of different cost accounting systems against each other. Through the targeted promotion of analytical and networked thinking, they have a pronounced cost awareness. They are able to develop and present their own solutions for selected decision-making situations.
3	Contents: - Basics of cost and performance accounting - Cost-type accounting - Cost unit accounting - Unit costing - Cost unit time accounting - Cost accounting systems - Decision-oriented cost accounting
4	Forms of teaching: Lecture, sem. lessons
5	Participation requirements: Formal: None Content: The module General Business Administration (1002) should have been completed
6	Forms of assessment: Written examination, combination examination, performance 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) Engineering Computer Sciences B.Eng. and Industrial Engineering and Management B.Sc.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr. rer. pol. Hubertus Wameling

11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

Cryptography					KRY
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1133	240 h	8	5th or 6th sem.		1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	0	SCH	0	h	0	h
	Sem. lessons	30 students	4	SCH	60	h	180	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:

The students know the basic principles, in particular the public key procedures, of cryptography. They are able to understand and implement practical algorithms from number theory

3 Contents:

- Basic properties of the Z and Z/(n) rings
- Prime number tests and factorisation methods
- Simple cryptosystems for encryption
- Public key cryptosystems
- Cryptographic applications of discrete logarithms
- Cryptographic applications of discrete quadratic equations
- Cryptographic hash functions
  Digital signatures

4 Forms of teaching:

Sem. lessons

5 Participation requirements:

Formal:	
Content:	Modules: 1003 Analysis; 1139 Linear Algebra;

6 Forms of assessment:

Term paper, written examination, combination examination, course assessment, performance examination, project work, oral examination or examination accompanying the course

7 Prerequisite for the award of credit points:

Module examination pass

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

Applied Mathematics B.Sc. and Engineering Computer SciencesComputer Sciences B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10 Module Coordinator:

Prof. Dr. phil. Bernhard Bachmann

11 Other information:

Literature will be announced at the beginning of the course.
The course material is summarised in a script that accompanies the lecture.

12 Language:

German

Power Electronics					LE
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3123	150 h	5	5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Sem. lessons	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	46	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	1.5	SCH	24	h	0	h

2 Learning outcomes/competences:

The module provides knowledge of the most important power semiconductors and the power converter circuits that can be realised with them. Students should be able to explain the physical functioning of semiconductors and, in particular, to describe the basic circuits of semiconductor converters for converting, controlling and switching electrical energy.

3 Contents:

General
Switching of ohmic-inductive loads
Introduction to power semiconductors

Thermal conductivity model

Switching behaviour of power semiconductors

Converter circuits
Single-pulse rectifier
Multi-pulse rectifier
Boost/buck converter
H-Bridge inverter
Three-phase inverters

Harmonics and power

Application circuits in automation
Switching power supplies
Electronic switches
Electronic actuators
Electromagnetic compatibility (EMC)

4 Forms of teaching:

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

5 Participation requirements:

Formal:	None
Content:	None

6	Forms of assessment: Term paper, written examination, project work 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) Mechatronics/Automation (work-integrated) B.Eng. and Industrial Engineering and Management (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr.-Ing. Michael Leuer
11	Other information: Supplementary literature will be announced at the beginning of the course.
12	Language: German

Marketing and Technical Sales					MUV
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3355	150 h	5	6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Sem. lessons	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	62	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

On successful completion of the module, students will be able to:

- Explain the specifics of marketing and the differences between business-to-business (B2B) and business-to-consumer (B2C) marketing;
- Compare the different methods of market research for analysing B2C and B2B markets;
- Identify the success factors and objectives of technical sales and review the determinants of the distribution channel decision;
- Describe the tools of the marketing mix (4P, Product, Price, Promotion and Place) and evaluate them with a focus on sustainability aspects;
- Classify current market trends against the background of increasing digitalisation, internationalisation and sustainability aspects;
- Interpret the essential concepts of sustainable marketing and basic models for explaining sustainable consumer behaviour;
- Apply the marketing mix design options to selected case studies;

•Discuss questions about structures and concepts in the sales of technical products in learning groups, develop your own solutions and present the results.

3 Contents:

- Digitalisation and sustainability as trends in marketing
- Innovations and influences of behavioural economics
- Customer satisfaction and loyalty as marketing targets
- Buying behaviour in B2C and B2B markets
- Market research and segmentation
- Product policy in the individual product lifecycle phases
- Strategies of price and conditions policy
- Sales forms and channel decisions
- Basic tools/metrics of sales controlling
- Elements of on- and offline communication

4 Forms of teaching:

Lecture notes, sem. lessons, exercises, case studies

5 Participation requirements:

Formal:	None
Content:	None

6 Forms of assessment:

Written exam, project work or oral exam

7 Prerequisite for the award of credit points:

Module examination pass

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

Digital Technologies (work-integrated) B.Eng. and Industrial Engineering and Management (work-integrated) B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10	Module Coordinator: Prof. Dr. Adam-Alexander Manowicz
11	Other information: Literature will be announced before the start of the course.
12	Language: German

Machine Learning and Data Mining					MLDM
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1314	150 h	5	4th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

- Students describe numerical data with the help of common statistical measures and visualise them using different types of diagrams.
- They use correlation analysis and regression to detect relationships between data series in multidimensional data sets.
- They can explain the history and basis of machine learning and data mining and relate them to their practical applications.
- They master the use of common dimension reduction and feature selection methods in practical application.
- They can find clusters of related data points in multi-dimensional data sets and assess their quality.
- They classify data using classification methods from statistical learning theory (such as support vector machines) and from the field of artificial neural networks.
- They use artificial neural networks to learn mappings between arbitrary input and output data. They have a comprehensive overview of machine learning and data mining methods and can assess which methods should be used in which application scenarios.

3 Contents:

- Basics of descriptive statistics
- Data visualisation
- Correlation analysis and regression
- Basics of machine learning and data mining
- 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 any input-output relationships (e.g. with artificial neural networks)

4 Forms of teaching:

- Lecture
- Sem. lessons
- Practical data analysis tasks

5 Participation requirements:

	Formal:	
	Content:	• Content of all mathematics modules in the bachelor's degree study programme in Engineering Computer Sciences • Generaladvanced programming knowledge (from the Computer Science 1 and Computer Science 2 modules) • Advanced programming knowledge in Python (from the Algorithms and Data Structures module) Modules: 1001 Algorithms and Data Structures; 1105 Computer Science 1; 1109 Computer science 2; 1147 Mathematics A; 1153 Mathematics B; 1158 Mathematics C
6	Forms of assessment: Oral examination or examination accompanying the course	
7	Prerequisite for the award of credit points: Module examination pass	
8	Application of the module (in the following study programmes) Engineering Computer Sciences B.Eng.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module Coordinator: Prof. Dr.-Ing. Wolfram Schenck	
11	Other information: Literature will be announced in the course.	
12	Language: German	

Mathematics A					MA A
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1147	300 h	10	1st sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	4	SCH	60	h	90	h
	Sem. lessons	30 students	4	SCH	60	h	90	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:

Students safely transform elementary equations, solve them and determine solvability if necessary. They know the elementary functions and their properties and apply them confidently.
Students understand the concept of limit and continuity and calculate both with a high degree of confidence. In doing so, they select suitable procedures with justification and apply them correctly.
Students understand the basic concepts of derivative and integral and calculate both with a high degree of confidence. In doing so, they select suitable procedures and apply them correctly.
Simple mathematical problems as well as applications from physics and electrical engineering are independently converted into formulas and solved by the students; logical conclusions are drawn and the reasonableness of the solution is checked. Students recognise connections and transfer their knowledge and skills to related tasks. They appropriately assess their own strengths and weaknesses and develop a picture of their own development in their studies.

3 Contents:

- Sets, union and average, number sets
- Transforming and solving equations and inequalities
- Elementary functions (power, root, exponential and logarithm functions, trigonometric functions) and their properties, inverse functions
- Limit value of sequences, series and functions, as well as continuity
- Differential calculus, slope, derivative, tangent, differentiation rules
- Newton's method
- Higher derivatives, extreme value tasks
- Integral calculus, area and integral, main theorem of infinitesimal calculus, integration rules, integration methods
- Applications of differential and integral calculus

4 Forms of teaching:

Lecture, sem. lessons

5 Participation requirements:

Formal:	None
Content:	None

6 Forms of assessment:

Written examination or oral examination; each with preliminary examination

7 Prerequisite for the award of credit points:

Module examination pass with preliminary examination

8	Application of the module (in the following study programmes) Engineering Computer Sciences B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr. rer. nat. Antje Ohlhoff
11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

Mathematics B					MA B
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1153	150 h	5	2nd sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	2	SCH	30	h	45	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:

Students can calculate with vectors, matrices and determinants. Students understand and determine the concepts of linear independence and rank of a matrix. Matrix, scalar and vector product are calculated and correctly applied. The students discuss the solvability of linear systems of equations, select suitable methods for the solution on the basis of this and apply them correctly.
They confidently apply straight line and plane equations.
Students understand the concept of complex numbers and deal confidently with the different forms of representation. Complex functions are calculated and applied. Simple AC circuits are calculated correctly.
Mathematical problems as well as applications from physics and electrical engineering are independently converted into formulae and solved by the students; logical conclusions are correctly drawn and the meaningfulness of the solution is checked. Students are able to think abstractly, analytically and logically to a large extent, recognise connections and creatively transfer their knowledge and skills to related tasks. They assess their own strengths and weaknesses appropriately and develop a picture of their own development in their studies.

3 Contents:

- Linear algebra: Vectors, matrices and determinants and how to calculate them
- Linear independence, rank of a matrix
- Matrix, scalar and vector product, angle and area calculation
- Solvability and solution of linear systems of equations
- Straight line and plane equations, homogeneous coordinates
- Complex numbers: arithmetic, trigonometric and exponential form
- Eulerian relation
- Exponentiation and radixing in the complex, complex functions
- Introduction to complex alternating current calculation

4 Forms of teaching:

Lecture, sem. lessons

5 Participation requirements:

Formal:	None
Content:	None

6 Forms of assessment:

	Written examination or oral examination; each with preliminary examination
7	Prerequisite for the award of credit points: Module examination pass with preliminary examination
8	Application of the module (in the following study programmes) Engineering Computer Sciences B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr. rer. nat. Antje Ohlhoff
11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

Mathematics C					MA C
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1158	150 h	5	2nd sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	2	SCH	30	h	45	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:

The students understand the basic concept of differential calculus for functions of several variables. They confidently calculate partial derivatives, tangential planes and total differential and apply them correctly.
Taylor series are safely calculated and applied.
Students are largely confident in dealing with ordinary differential equations and their applications. In doing so, they select suitable procedures for the solution and apply them correctly.
Mathematical problems and applications from physics and electrical engineering are independently converted into formulas and solved by the students. In the process, suitable methods are selected for practical problems, logical conclusions are correctly drawn and the reasonableness of the solution is checked. Students can think abstractly, analytically and logically, recognise connections and creatively transfer their knowledge and skills to related tasks. They assess their own strengths and weaknesses appropriately and develop a picture of their own development in their studies.

3 Contents:

- Taylor series
- Differential calculus for functions of several variables, partial derivatives, tangential plane, total differential and applications
- Ordinary differential equations, dynamic systems
- Analytical methods for the solution of ordinary differential equations
- Applications of ordinary differential equations

4 Forms of teaching:

Lecture, sem. lessons

5 Participation requirements:

Formal:	None
Content:	None

6 Forms of assessment:

Written examination or oral examination; each with preliminary examination

7 Prerequisite for the award of credit points:

Module examination pass with preliminary examination

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

Engineering Computer Sciences B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10	Module Coordinator: Prof. Dr. rer. nat. Jörg Horst
11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

Metrology					MT
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1169	150 h	5	3rd or 5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2	Learning outcomes/competences: The students know the general principles of metrology and the basic electrical measuring methods. They know the causes of measurement deviations and the basics of error calculation. They know how digital and electromechanical measuring instruments work in principle and can handle measuring instruments. After completing the module, they will be able to select a device suitable for a measurement task, design a measurement circuit, perform the measurements, present the measurement results in a suitable manner and perform an error analysis.
3	Contents: • Basics, basic circuits • Digital and electromechanical measuring instruments • Error calculation and causes of measurement deviations • Measurement of electrical quantities • Stationary and dynamic behaviour of measuring systems
4	Forms of teaching: Lecture, sem. lessons and practical course
5	Participation requirements: Formal: no modules: 1075 Electrical Engineering 2; 1075 Electrical Engineering 2; Content:
6	Forms of assessment: Written examination; each with preliminary examination
7	Prerequisite for the award of credit points: Module examination pass with preliminary examination
8	Application of the module (in the following study programmes) Electrical Engineering B.Eng., Engineering Computer Sciences B.Eng. and Renewable Energies B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr. rer. nat. Thomas Westerwalbesloh
11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

Microsystems Technology					MST
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1174	150 h	5	6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	0	SCH	0	h	0	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	2	SCH	30	h	45	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

- Knowledge of the materials and technologies of microelectronics and microsystems technology
- Knowledge of the main fields of application in sensor and actuator technology
- Capabilities for systematising data sheet information of micro-electromechanical systems (MEMS)
- Knowledge of system integration of MEMS
- Knowledge and skills in the simulation techniques
- Practical competence in the realisation of sensor systems with MEMS

3 Contents:

1. Materials and technologies of microsystems engineering and microelectronics
2. Sensors
   - Acceleration sensors
   - Rotation rate sensors
   - Pressure sensors
3. System integration
4. Actuators
5. Simulation of MEMS

4 Forms of teaching:

Lecture, practicals

5 Participation requirements:

Formal:	None
Content:	None

6 Forms of assessment:

Written examination, combination examination or oral examination; each with preliminary examination performance

7 Prerequisite for the award of credit points:

Module examination pass with preliminary examination

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

Engineering Computer Sciences B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10 Module Coordinator:

Prof. Dr.-Ing. Dirk Zielke

11 Other information:

Literature will be announced at the beginning of the course.

12 Language:

German

Networks and Bus Systems					NBS
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1180	150 h	5	5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	2	SCH	30	h	45	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:

With reference to the contents listed below, students name and identify the elementary terms, interrelationships, requirements and classifications of networked systems. They can analyse the industrial communication of automation solutions and design and evaluate simple systems.

3 Contents:

- Communication models and network hierarchies
- Network topologies
- Serial and parallel bus systems
- Transmission media, data backup and coding, bus access procedures
- Real-time capability
- Classic fieldbus systems, especially CANopen, PROFIBUS and LON
- Ethernet and TCP/IP protocols, Ethernet-based fieldbus systems, especially POWERLINK, Ether-CAT, PROFINET and TSN
- OPC-UA

4 Forms of teaching:

Lectures, exercises, practicals

5 Participation requirements:

Formal:	None
Content:	None

6 Forms of assessment:

Term paper, written examination, combination 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)

Electrical Engineering B.Eng. and Engineering Computer Sciences B.Eng.

9 Importance of the grade for the final grade:

according to BRPO or SPO if ungraded elective subject

10 Module Coordinator:

Prof. Dr.-Ing. Andreas Bünte

11 Other information:

Literature will be announced at the beginning of the course.
see ILIAS

12 Language:

German

Network Technology					NW
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1181	150 h	5	3rd or 5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

- Students explain the basics of setting up local area networks (LAN).
- Students have a basic knowledge of the protocols used. They plan and simulate simple networks, set them up in the laboratory with a partner, configure the network devices used (router, switch, PC) and discuss the results of their work.
- The students assign the processes in an IP network to the layers of the OSI or the TCP/IP model. They can detect and eliminate configuration errors in a LAN.
- Students are familiar with the role of a switch and configure virtual LANs (VLAN).
- The students name possibilities to protect a LAN from non-authorised attacks (e.g. hackers).

3 Contents:

- Architecture and application of computer-aided communication systems,
- Media for data transmission,
- Local networks and their characteristics,
- Subnet formation also with variable subnet lengths (VLSM),
- Protocols of data transmission in networks (network and transport layer),
- Function of important network coupling devices (especially router, switch),
- Configuration of active components for setting up networks,
- Application level services and protocols,
- Simulation and practical construction of computer networks.

4 Forms of teaching:

Lecture, sem. lessons, project and group work within the framework of the internship

5 Participation requirements:

Formal:	None
Content:	None

6 Forms of assessment:

Written examination, combination examination or oral examination; each with preliminary examination performance

7 Prerequisite for the award of credit points:

Module examination pass with preliminary examination

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

Electrical Engineering B.Eng., Engineering Computer Sciences B.Eng. and Mechatronics B.Sc.

9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr.-Ing. Lutz Grünwoldt
11	Other information: Literature will be announced at the beginning of the course. Lecture notes will be provided. Each student will be a member of a Cisco class and will have access to a simulation environment and extensive online curricula. Certificates can be issued for successful participation in Cisco final exams.
12	Language: German

Numerical Mathematics					NM
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1007	150 h	5	4th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	30	h	45	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 know essential mathematical basics for the numerical solution of application problems. The critical examination of theoretical approaches is conveyed in the discussions and deepened through practical implementation. On this basis, they can assess the possibilities and limitations of numerical methods and select appropriate methods for practical problems.
3	Contents: The course teaches the basics of the numerical treatment of problems that occur frequently in engineering sciences: - Root-finding algorithms - Linear algebra (solutions of large linear/non-linear equation systems) - Interpolation - Numerical differentiation and integration - Regression - Applications from nature and technology
4	Forms of teaching: Lecture, exercise
5	Participation requirements: Formal: None Content: Mathematics 1 (1147), Mathematics 2 (1153), Mathematics 3 (1158), Mathematics 4
6	Forms of assessment: Term paper, written examination or combination exam
7	Prerequisite for the award of credit points: Module examination pass
8	Application of the module (in the following study programmes) Engineering Computer Sciences B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr. rer. nat. Christian Schröder
11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

Numerical Simulation					NSI
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1008	150 h	5	5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	15	h	22.5	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2	Learning outcomes/competences:	
	The students master the theoretical basics of different numerical simulation methods and know how to use them to solve scientific and technical problems. The critical examination of theoretical approaches against the background of solving practical problems is conveyed in the discussions as well as deepened through practical implementation with the support of simulation tools.	
3	Contents:	
	- Mathematical tools - Fundamentals and classification of partial differential equations - Methods for the numerical solution of partial differential equations - Applications from natural science and technology	
4	Forms of teaching:	
	Lecture, exercise, practical course	
5	Participation requirements:	
	Formal:	None
	Content:	Linear Algebra (1139), Analysis (1003), Numerical Mathematics (1007 or 1186)
6	Forms of assessment:	
	Term paper, written examination or combination exam	
7	Prerequisite for the award of credit points:	
	Module examination pass	
8	Application of the module (in the following study programmes)	
	Engineering Computer Sciences B.Eng.	
9	Importance of the grade for the final grade:	
	according to BRPO	
10	Module Coordinator:	
	Prof. Dr. rer. nat. Christian Schröder	
11	Other information:	
	Literature will be announced at the beginning of the course.	
12	Language:	
	German	

Optical Systems Engineering					OST
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1300	150 h	5	6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2	Learning outcomes/competences: Students will be able to analyse typical applications for the use of optical sensor systems and evaluate them for economic application under production conditions. The focus here is on efficient implementation in automated production. Furthermore, the handling of different optical systems is taught both theoretically and practically, so that simple test systems can be designed independently.
3	Contents: - Difference between image processing and machine vision - Fundamentals of optical systems engineering - Physical properties of light / areas of application of optical system technology - Smart sensors and cameras - Lighting and optics - Machine vision software - Selected filters and special software tools - Colour machine vision and spectroscopy - Interfaces for communication with machine controls - Selected real-life application examples of the various sensor classes - Two-dimensional coding, recording and communication with ERP systems. Distinction between reading and verification
4	Forms of teaching: Lecture, sem. lessons, practical course
5	Participation requirements: Formal: None Content: None
6	Forms of assessment: Combination examination, performance 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) Engineering Computer Sciences B.Eng. and Industrial Engineering and Management B.Sc.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr. rer. nat. Marc-Oliver Schierenberg
11	Other information:

	Literature will be announced at the beginning of the course.
12	Language: German

Optoelectronics					OPT
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1190	150 h	5	5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

The students have a basic knowledge of the elementary correlations and physical laws of light generation and detection using electronic components.
They have gained knowledge of the most important semiconductor components for converting electrical signals into optical signals and vice versa, including their manufacture and mode of operation. They have gained an overview of the areas of application of these components and can select and use them for practical applications.
Students have gained practical skills in simple optical experimentation and in dealing with special optical components as well as tabular and graphic processing of measurement results

3 Contents:

- Physical principles of the properties of light and propagation of electromagnetic waves
- Semiconductor electronics: Fundamentals and interaction of light and matter
- Radiation detectors: thermal detectors, quantum detectors (e.g. photocells, photoresistors, photodiodes, phototransistors, CCD devices, CMOS sensors, etc.)
- Radiation emitting devices: Luminescent diodes, laser diodes, etc.
- Optical transmission technology with optical fibres

4 Forms of teaching:

Lecture, sem. lessons and practical training in small groups (2 - 4 participants)

5 Participation requirements:

Formal:	
Content:	Basic physics and electrical engineering modules, as well as those listed below: Modules: 1066 Electronics 1; 1068 Electronics 2; 1071 Electrical Engineering 1; 1075 Electrical Engineering 2;

		1169 Metrology; 1195 Physics 1; 1200 Physics 2;
6	Forms of assessment: Oral examination; in each case with preliminary examination	
7	Prerequisite for the award of credit points: Module examination pass with preliminary examination	
8	Application of the module (in the following study programmes) Electrical Engineering B.Eng. and Engineering Computer Sciences B.Eng.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module Coordinator: Prof. Dr. rer. nat. Sonja Schöning	
11	Other information: Literature will be announced at the beginning of the course. Students must have sufficient knowledge and experience in the use and safety of electrical equipment	
12	Language: German	

Personnel and Organisation					PUO
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1192	150 h	5	4th or 6th sem.	Annual (Summer	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	3	SCH	45	h	67.5	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	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:

The students have a basic overview of the tasks of human resource management. They know the essential methods of personnel recruitment, personnel development and personnel evaluation and can evaluate them with regard to their suitability and applicability.
They are familiar with essential theoretical concepts on communication, understand They are familiar with essential theoretical concepts on communication; they understand the problems that can occur during the communication process and have practised possible solutions.
They understand the importance of learning for change processes and can design the conditions for successful learning.
They can explain the principles of organisational theory and have checked their significance using practical examples. They can use organisational forms with regard to their applicability.
They are familiar with important topics of organisational change and can assess their significance for entrepreneurial activity.
They have basic knowledge about the characteristics and significance of key qualifications and have demonstrated this with examples, e.g. regarding the conflict resolution and motivational skills.

3 Contents:

Significance, goals and tasks of human resources management
Fundamentals of labour law
Fundamentals of Communication
Fundamentals of Learning Theory
Environmental conditions, learning control, strategies for lifelong learning
Organisational and operational structure, forms of primary and secondary organisation
Organisational change
Personnel management and conflict resolution

4 Forms of teaching:

Lecture, sem. lessons with exercises and case studies

5 Participation requirements:

Formal:	None
Content:	None

6 Forms of assessment:

	Written examination, combination examination, performance 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) Engineering Computer Sciences B.Eng., Renewable Energies B.Eng. and Industrial Engineering B.Sc.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr. rer. oec. Thomas Süße
11	Other information: Literature will be announced at the beginning of the course. Renewable Energies study programme: Possible elective subject
12	Language: German

Physics 1					PH1
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1195	150 h	5	1st sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

The students know the structure and methodology of physics and have basic knowledge of the fundamental laws of nature of classical mechanics. They can analyse and mathematically describe motion sequences of mass points and simple bodies. They recognise problem contexts and can solve technical questions independently.
Students can carry out experiments, evaluate measurements and present the results clearly. They know the methods of error estimation of measurement results and can independently produce reports on laboratory experiments during the practical course.

3 Contents:

- Physical quantities and units
- Measurement accuracy and measurement errors
- Basic concepts of classical mechanics
- Kinematics: Description of motion
- Dynamics: Newton's laws of motion
- Work and energy, conservation of energy
- Momentum and collisions
- Rotations and angular momentum
- Basic concepts of fluid mechanics

4 Forms of teaching:

Lecture, seminar with practice-oriented exercises, basic physics practical course - Part 1 (3 experiments)

5 Participation requirements:

Formal:	None
Content:	None

6 Forms of assessment:

Written examination; each with preliminary examination

7 Prerequisite for the award of credit points:

module examination pass with preliminary examination

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

Electrical Engineering B.Eng. and Engineering Computer Sciences B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10 Module Coordinator:

Prof. Dr. rer. nat. Lars Fromme

11 Other information:

Literature will be announced at the beginning of the course.

12	Language: German

Physics 2					PH2
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1200	150 h	5	2nd sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

The students have basic knowledge of the fundamental physical laws of nature, especially in the areas of thermodynamics, oscillations and waves and optics. They can systematically apply basic physical principles to technical problems and work out solutions independently.
The students know the scientific working method with the alternating effect of experiment and theory and can apply it. They have skills to prepare and conduct their own experiments, as well as document and critically assess the results.

3 Contents:

- Thermodynamics: Temperature, ideal gas law, laws of thermodynamics, thermal properties and processes
- Oscillations: simple harmonic motion, damped and driven oscillations, resonance
- Waves: Wave propagation, interference, reflection, transmission, refraction, diffraction, acoustic waves
- Optics: Geometrical optics, optical systems, wave optics, polarisation

4 Forms of teaching:

Lecture, seminar with practice-oriented exercises, basic physics practical course - Part 2 (3 experiments)

5 Participation requirements:

Formal:	None
Content:	Contents of the module Physics 1 (1195) Modules: 1195 Physics 1

6 Forms of assessment:

Written examination; each with preliminary examination

7 Prerequisite for the award of credit points:

module examination pass with preliminary examination

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

Electrical Engineering B.Eng. and Engineering Computer Sciences B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10 Module Coordinator:

Prof. Dr. rer. nat. Lars Fromme

11 Other information:

Literature will be announced at the beginning of the course.

12	Language: German

Practical Project / Internship					PRA
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1292	450 h	15	7th sem.	each semester	12 weeks

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	0	SCH	0	h	450	h
	Sem. lessons	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 practical project, the activities and learning outcomes imparted in the course of study are to be applied in a practice-oriented manner. To this end, students should work independently on engineering projects and develop suitable solution strategies. The main aim is to develop and expand integration, analysis and problem solving, presentation and communication skills.	
3	Contents:	
	The contents result from the field of activity of the respective chosen company or enterprise and should include an engineering task. At the end of the practical project, the supervising company is to prepare an activity report and the students a final report. During the practical project, the students should receive individual and professional advising from the supervising university lecturers.	
4	Forms of teaching:	
	Sem. lessons with exercises as accompanying guidance	
5	Participation requirements:	
	Formal:	None
	Content:	None
6	Forms of assessment:	
	Term paper	
7	Prerequisite for the award of credit points:	
	Module examination pass	
8	Application of the module (in the following study programmes)	
	Electrical Engineering B.Eng., Engineering Computer Sciences B.Eng., Mechanical Engineering B.Eng., Mechatronics B.Sc., Renewable Energies B.Eng. and Industrial Engineering and Management B.Sc.	
9	Importance of the grade for the final grade:	
	according to BRPO	
10	Module Coordinator:	
	N.N.	
11	Other information:	
	Literature will be announced at the beginning of the course.	
12	Language:	
	German	

Quality Management					QM
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1229	150 h	5	4th or 6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	2	SCH	30	h	45	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:

The students are able to

- Define the basic concepts of quality theory.
- Explain the basics of building a quality management system.
- Implement standard requirements for a quality management system in a familiar field of work by being able to identify requirements, formulate goals and describe processes based on the defined terms and principles of quality management.
- Make important business decisions based on basic, relevant statistical methods.
- Classify the industrial application of quality methods and techniques in the product creation process.
- Master the essential quality methods and techniques, such as FMEA, QFD, Poka Yoke, SPC, test planning.
- Understand the systematic and structured application of basic methods from the scope of quality management in the context of improvement projects.
- Systematically identify, eliminate and avoid the causes of errors by selecting and applying the appropriate methods for data collection, data analysis and root cause identification for the intended purpose in order to subsequently react and preventively solve quality problems.
- Assess the role of quality management in development, procurement and production.
- Analyse significant variables and risks with regard to the quality level of a production.
- Evaluate and analyse quality data from production and derive measures for production process optimisation.
- Highlight legal aspects of warranty and product liability.

3 Contents:

1 Understanding quality
- The term quality
- Quality and its characteristics
- Quality management

2 Quality management systems
- Standards and models for QM systems
- ISO 9000 series of standards
- Process orientation

3 Quality tools
- Data collection tools
- Tools for data analysis

4 Management and creativity tools
- Management tools (M7)
- Creativity tools (K7)

5 Quality management in development
- Kano model
- Quality Function Deployment
- FMEA

6 Statistical design of experiments
- Classical design of experiments
- Optimum search procedure
- Robust processes according to Taguchi

	- Improvement strategies according to Shainin 7 Quality controlling - Quality cost models - Quality cost accounting 8 Quality management in procurement - Definition of procurement strategies - Factors of supplier selection - Negotiate quality management contracts - Initial sample testing - Incoming goods inspection 9 Statistical methods in quality management - Sampling and population - Distributions - Visualisation of data - Correlations - Linear regression analysis 10 Six Sigma - Introduction to Six Sigma - DMAIC cycle as a systemic approach 11 Quality management in production - Quality testing - Test equipment management - Proof of suitability of measuring systems - Statistical process control 12 Quality management during field use - Field data management - Isochronous diagram - Weibull analysis
4	Forms of teaching: Lecture, seminar lessons, supplemented by guest lectures
5	Participation requirements: Formal: None Content: None
6	Forms of assessment: Written examination, combination 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) Biotechnology and Instrumentation Engineering B.Sc., Engineering Computer Science B.Eng. and Mechatronics B.Sc.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr.-Ing. Magnus Horstmann

11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

Computer Architectures					RA
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1231	150 h	5	5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

- The students know how modern computer hardware works, especially microprocessors.
- Based on the concept of a Von Neumann computer, students evaluate and analyse various basic architecture concepts.
- The students explain how Von Neumann computers can be programmed at the machine level.
- They convert number representations between any position systems.
- They explain the representation of integers and floating point numbers in different binary encodings.
- They know memory hierarchies and bus systems and advanced architecture concepts.
- They explain the computer architecture of graphics processors and analyse it in comparison to conventional computer architectures.
- They solve small programming tasks using IA-32 assembler.
- They develop small programmes for scientific computing on graphics processors (e.g. using CUDA C).

3 Contents:

- Historical overview of computer architectures
- Von Neumann architecture
- Design of digital computers and their components
- Basic functioning of processors at the register transfer level (especially in the processing of machine instructions)
- Computer arithmetic (ALUs, FPUs, encoding of numbers and characters)
- Memory hierarchy (cache)
- Bus systems
- Advanced architecture concepts (pipelines, out-of-order execution, etc.)
- Computer architecture of graphics processors Programming in IA32 assembler
- Programming of graphics processors (e.g. via CUDA C)

4 Forms of teaching:

Lecture, sem. lessons (exercises if necessary), practical programming tasks in IA32 assembler, practical tasks for the programming of graphics processors

5 Participation requirements:

Formal:	None

	Content:	• Basic computer science and programming knowledge • Basic knowledge of digital technology Modules: 1045 Digital Electronics II; 1070 Digital Electronics I; 1105 Computer Science 1;
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) Electrical Engineering B.Eng., Engineering Computer Sciences B.Eng. and Mechatronics B.Sc.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module Coordinator: Prof. Dr.-Ing. Wolfram Schenck	
11	Other information: Literature will be announced at the beginning of the course.	
12	Language: German	

Feedback Control Engineering					RT
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1233	150 h	5	4th sem.	Annual Summer	1 sem.

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

Students:

- have basic knowledge in the field of system theory.
- can create models for simple physical systems.
- can transform differential equations into the state space. They investigate and evaluate the dynamic behaviour of linear time-invariant systems.
- can recognise and explain connections between the time domain representation and the frequency domain.
- explain the standard control loop and name the variables in the loop.
- can systematically analyse control engineering problems.
- examine single-loop feedback systems for stability.
- assess the properties of a control loop with regard to dynamics and disturbance behaviour.
- design single-loop control loops on real-world systems in the laboratory. They can discuss the results and derive measures.

3 Contents:

- Structural description of dynamic systems
- Description of linear systems in the time domain (differential equations, state space representation, linearisation of non-linear systems)
- Behaviour of linear systems (input/output behaviour, impulse response, canonical form, controller canonical form, determination of characteristic values of LTI systems)
- Description and analysis of linear systems in the frequency domain, integral transforms (Fourier, Laplace)
- Frequency response and transfer function
- Standard control loop and controller design
- Command response and disturbance rejection of closed-loop control
- Stability of feedback systems (Nyquist stability criterion).
- Design of single-loop feedback systems (frequency characteristics, root locus)
- Practical course in control engineering

4 Forms of teaching:

Lecture, sem. lessons with exercises, practical course

5 Participation requirements:

Formal:	None
Content:	Modules: 1147 Mathematics A; 1153 Mathematics B; 1158 Mathematics C;

6	Forms of assessment: Written or oral examination; in each case with preliminary examination performance
7	Prerequisite for the award of credit points: Module examination pass with preliminary examination
8	Application of the module (in the following study programmes) Engineering Computer Sciences B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr.-Ing. Martin Kohlhase
11	Other information: Literature will be announced at the beginning of the course. Notes in the course
12	Language: German

Robotics					ROB
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1240	150 h	5	5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

The students know the elementary concepts and basics of standard manipulators. Students master the basic descriptive tools and methods for modelling and calculating the forward kinematics of a kinematic chain. Through the presentation and discussion of current robot systems (incl. mobile robot systems and multimodal sensor systems), the students can grasp both the practical significance of robotics and different approaches to robot development. They will thus become capable of independent engineering thinking and working in robotics and related areas of application.

3 Contents:

Teaching content:
- Manipulators
- Robot kinematics (incl. mathematical foundations)
- Forward and inverse kinematics
- Mobile robots
- Sensors for mobile robots
- Artificial intelligence and robotics
- Behaviour-based robotics
- Learning robots

4 Forms of teaching:

Lecture, sem. lessons with exercises, practical course

5 Participation requirements:

Formal:	None
Content:	Mathematics 1 and 2, Computer Science, Engineering Mechanics, Electrical Engineering 1 and 2, Physics

6 Forms of assessment:

Written examination, combination examination, performance 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)

Biotechnology and Instrumentation Engineering B.Sc., Electrical Engineering B.Eng., Engineering Computer Sciences B.Eng., Mechatronics B.Sc. and Industrial Engineering and Management B.Sc.

9 Importance of the grade for the final grade:

according to BRPO

10 Module Coordinator:

Prof. Dr. rer. nat. Martin Hülse

11 Other information:

	Literature and other sources will be announced at the beginning of the course.
12	Language: German

Sensors					SEN
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1242	150 h	5	4th or 6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

The students know some basic sensor principles (inductive, capacitive, resistive, etc.) and know the physical mechanisms of action. They know typical electrical and electronic circuits for upgrading and amplifying the sensor output. The students can select a suitable sensor for the most common measuring tasks and design a measuring circuit. They can present measured results in a suitable way and document the results of their work.

3 Contents:

- Measuring amplifier
- AD converter types
- Measuring bridges
- Inductive, capacitive and resistive sensors
- Temperature measurement
- Optical sensors

4 Forms of teaching:

Lecture, sem. lessons and laboratory exercises

5 Participation requirements:

Formal:	Modules: 1068 Electronics 2; 1169 Metrology
Content:	Modules: 1075 Electrical Engineering 2

6 Forms of assessment:

Written examination; each with preliminary examination

7 Prerequisite for the award of credit points:

Module examination pass with preliminary examination

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

Electrical Engineering B.Eng. and Engineering Computer Sciences B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10 Module Coordinator:

Prof. Dr.-Ing. Thomas Westerwalbesloh

11 Other information:

Literature will be announced at the beginning of the course.

12	Language: German

Signals and Systems					SigSys
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1121	150 h	5	4th or 6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

After completing the module, students can

- name the different signal representations in time, frequency and image ranges, select the appropriate transformations and apply them,
- recognise linear and non-linear time-varying systems and explain their essential properties,
- calculate and evaluate the transition from analogue to digital signals,
- name analogue and digital modulation methods and critically compare their characteristics

3 Contents:

- Level calculation,
- Continuous-time signals and their functional transformations (Fourier series, Fourier transform, Laplace transform),
- Discrete-time signals and their functional transformations (z-transform, discrete Fourier transform)
- Fundamentals of spectral analysis
- Linear time invariant systems
- Linear and non-linear distortions
- The sampling theorem
- Methods of analogue and digital modulation processes
- Three laboratory practicals in small groups

4 Forms of teaching:

Lecture, sem. lessons, laboratory practicals in small groups.

5 Participation requirements:

Formal:	None
Content:	Mathematics 1 (1146) and 2 (1152). Electrical Engineering 1 (1071) and 2 (1075)

6 Forms of assessment:

Written or oral examination; in each case with preliminary examination performance

7 Prerequisite for the award of credit points:

Module examination pass with preliminary examination

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

Electrical Engineering B.Eng. and Engineering Computer Sciences B.Eng.

9 Importance of the grade for the final grade:

	according to BRPO
10	Module Coordinator: Prof. Dr.-Ing. Rüdiger Schultheis
11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

Simulation Technology					SIM
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1244	150 h	5	5th sem.	Annual Winter	1 sem.

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

Students:

- have an overview of different approaches to model-based development.
- create mechanical and electrical models and implement them in graphical form (as block diagrams, for example) in a simulation environment (such as MATLAB/Simulink).
- calculate simulation parameters from models and configure the simulation software accordingly.
- simulate mechanical and electrical models on a computer and evaluate the simulation results.
- compare simulated time response of modelled systems with measured signals of real-world systems and assess the model quality and simulation accuracy.
- can discretise continuous time models and implement them on an embedded system in form of difference equations (z-transforms).
- understand the principles of (first-order) numerical procedures for solving ordinary differential equations (ODEs) and evaluate the different procedures in terms of efficiency, stability and accuracy.
- outline and explain numerical methods (e.g. in direction fields).

3 Contents:

- Introduction to simulation technology.
- Model-based development (software-in-the-loop, model-in-the-loop, hardware-in-the-loop and rapid control prototyping).
- Methods of modelling (state space form, descriptor model and representation in the form of block diagrams).
- Modelling of mechanical systems and electrical circuits.
- Ordinary differential equations (ODEs), state space models, extended state space models and introduction in descriptor equation.
- Structural singularities and algebraic loops.
- Introduction in sampled data systems and discrete-time systems (difference equations and z-transforms)
- Numerical methods for ordinary differential equations (Euler procedure, Heun procedure, family of Runge-Kutta procedures).
- Stability and accuracy of numerical methods.
- Introduction in linear multistep methods.
- Practical course in simulation

4 Forms of teaching:

	Lecture, sem. lessons with exercises, practical course	
5	Participation requirements:	
	Formal:	None
	Content:	Modules: 1233 Feedback Control Engineering;
6	Forms of assessment: Written or oral examination; in each case with preliminary examination performance	
7	Prerequisite for the award of credit points: Module examination pass with preliminary examination	
8	Application of the module (in the following study programmes) Electrical Engineering B.Eng., Engineering Computer Sciences B.Eng. and Mechatronics B.Sc.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module Coordinator: Prof. Dr.-Ing. Martin Kohlhase	
11	Other information: Literature will be announced at the beginning of the course.	
12	Language: German	

Social Media and Natural Language Processing					SMNLP
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3351	150 h	5	5th sem.	Annual (Winter)	1 Semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Sem. lessons	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	62	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

- Students outline the history and business model of social media.
- They explain the technologies behind it.
- They create scripts to retrieve data from social media and for web crawling (e.g. to extract blog content or newspaper articles).
- They describe the application areas of natural language processing and classify the techniques used there in the field of machine learning and data mining.
- They apply NLP methods for the syntactic and semantic analysis of text data.

They implement toolchains in which data from social media is analysed using NLP methods in order to answer typical questions from marketing and sales or from social sciences.

3 Contents:

- Introduction to social media (history, business model, technologies)
- Retrieving data from social media (APIs)
- Retrieving data from websites and blogs (web crawling)
- Introduction to natural language processing (NLP) (history, motivation, fields of application, relation to other techniques of data mining and machine learning)
- NLP methods for the syntactic analysis of text data (e.g. for parsing or sentence breaking)
- NLP methods for the semantic analysis of text data (e.g. for sentiment analysis)

Case studies from market research and from the social sciences

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5 Participation requirements:

Formal:	
Content:	• Mathematical basics • Basics of machine learning and data mining • Advanced programming skills

6 Forms of assessment:

	Written exam, project work or oral exam
7	Prerequisite for the award of credit points: Module examination pass
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: N. N.
11	Other information:
12	Language: German

Software Engineering					SWE
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1245	150 h	5	3rd or 5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	1	SCH	15	h	22.5	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	1	SCH	15	h	22.5	h
	Supervised self Study-	60 students	0	SCH	0	h	0	h

2	Learning outcomes/competences: Students know the basic principles of software engineering and can apply standard methods for the successful planning and implementation of software development projects. They are familiar with common UML diagram types. Students can use collaborative tools for version management in a team. They are able to plan and carry out software tests. They can explain the benefits and problems of using software products in technology and business and develop plans for their implementation.
3	Contents: - Requirements analysis and specification - Software design - Use of UML as a modelling language - Configuration management - Testing techniques - Process models
4	Forms of teaching: Lecture, sem. lessons with exercises, practical course
5	Participation requirements: Formal: None Content: Knowledge of object-oriented programming Modules: 1105 Computer Science 1; 1109 Computer Science 2
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) Engineering Computer Sciences B.Eng. and Industrial Engineering and Management B.Sc.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr. rer. nat. Georgios Lajios
11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

Statistics					STAT
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3224	150 h	5	3rd or 4th sem.	each semester	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Sem. lessons	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	62	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

Students:

- can explain basic concepts of statistics.
- can apply the basic methods and procedures of descriptive statistics and probability theory.
- are able to analyse economic questions and problems with statistical methods and to show correlations.
- are able to solve tasks with the help of suitable software (SPSS, Excel,...).

3 Contents:

- Descriptive statistics (one-dimensional frequency distributions, measures, multivariate statistics, regression analysis)
- Probability theory (discrete and continuous distributions)
- Statistical interference
- Use of Excel/SPSS

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:

Term paper, written examination, combined examination, project work, oral examination or examination accompanying the course

7 Prerequisite for the award of credit points:

Module examination pass

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

Digital Logistics (work-integrated) B.Eng., Digital Technologies (work-integrated) B.Eng., Mechatronics/Automation (work-integrated) B.Eng., Product-Service Engineering (work-integrated) B.Eng. and Industrial Engineering and Management (work-integrated) B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10 Module Coordinator:

Dr. rer. nat. Sabrina Proß

11 Other information:

-

12	Language: German

Student Research Project (Project 2)					STA
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1219	150 h	5	5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	0	SCH	0	h	0	h
	Sem. lessons	30 students	0	SCH	0	h	0	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	2	SCH	30	h	120	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

- Students work individually or in a group to develop solutions to a technical problem specified by an examiner (professor/lecturer) of the study programme. The processing is to take place within the university.
- The students have sufficient knowledge and skills to apply the methods of working in engineering science to solve a complex topic.
- The students independently obtain all necessary information, analyse the project goals and independently assess to what extent these goals can be achieved and how.
- The students usually document their work steps and solutions in written form and present them, critically reflecting on the achieved state of their work.

3 Contents:

- Information procurement
- Engineering project planning (milestones)
- Design of solution strategies
- Implementation of project goals
- Strategic use of all available sources of information
- Communication
- Presentation
- Quality assurance

4 Forms of teaching:

Term paper with planning “milestones” and final colloquium, regular feedback discussion and guidance by an examiner.

5 Participation requirements:

Formal:	None
Content:	None

6 Forms of assessment:

Homework 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)

Engineering Computer Sciences B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10 Module Coordinator:

Prof. Dr.-Ing. Lutz Grünwoldt

11	Other information: Faculty tutoring is provided in each case by an examiner from the study programme, whom the student can select himself or herself according to the topic. All lecturers in the programme should each provide several topics in time for the winter semester. If, at the proposal of the examiner, the course work is carried out as a joint project by several students, the examiner is responsible for ensuring that a clearly defined, significant and assessable share of the work is determined in advance for each student in the group. In a discussion with the examiner, the expected scope and form of the work is determined at the beginning of the student research phase.
12	Language: German

Team Project: Engineering Computer Sciences					PINI
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1218	150 h	5	3rd sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	0	SCH	0	h	0	h
	Sem. lessons	30 students	0	SCH	0	h	0	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	2	SCH	30	h	120	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

Students:

- form teams for a specific project.
- break down the project into subtasks, divide them up among themselves and name people responsible for the content and timely implementation.
- carry out project planning together, define goals and manage delimited tasks independently in small groups.
- discuss interface agreements, implement necessary software components and debug them in the team.
- solve conflicts, develop their understanding of their role in the team and take responsibility.
- justify decisions and present results.
- jointly prepare project documentation.

3 Contents:

- Planning, development and implementation of a given project in a team (e.g. control of a robot system on drive, kinematics, path planning and control level)
- Project planning and identification of requirements and target specifications
- Decomposition into subproblems and their distribution to subgroups of the team
- Milestone planning at team and subgroup level
- Agreeing on interfaces between the subgroups of a team
- Implementation of the necessary software components
- Debugging software
- Phases of system development from design to evaluation in the group
- Problem-solving and decision-making behaviour of the group members
- Presentation and documentation

4 Forms of teaching:

Group project in the lab

5 Participation requirements:

Formal:	None
Content:	Basic electronics and programming knowledge

6 Forms of assessment:

Term paper, combination 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)

Engineering Computer Sciences B.Eng.

9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Prof. Dr. rer. nat. Axel Schneider
11	Other information: Literature will be announced at the beginning of the course.
12	Language: German

Technical English 1					FSE1
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1085	150 h	5	1st semester3rd semester	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture		0	SCH	0	h	0	h
	Sem. lessons	30 students	4	SCH	60	h	90	h
	Exercise		0	SCH	0	h	0	h
	Practical or seminar		0	SCH	0	h	0	h
	Supervised self-study	30 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

- Expertise: Students demonstrate that they have extended their active general language competence from B1.2 and achieved a B2.1 level. They possess a sound basic vocabulary of technical English and master the contextually relevant grammar. They communicate spontaneously and fluently in engineering job situations. They formulate issues confidently, clearly and in detail in English both in speaking and writing.
- Social competence: They try out and consolidate communicative key skills in English presentations, teamwork and project work.
- Methodological competence: They use targeted strategies for content acquisition and critical analysis of technical texts and for solving contextual tasks. They can present technical issues in a way that is appropriate for the target group.
- Personal competence: They are able to take responsibility for their learning process; they research and structure authentic material, organise workloads and meet deadlines.

3 Contents:

- The students can describe relevant engineering disciplines.
- They master the core terminology of the technical topic (e.g. base units in engineering; dimensions and shapes; mathematical operations; forces and mechanisms; properties of materials; manufacturing and automation; energy and electricity; logistics; data processing and transmission).
- They possess interdisciplinary skills (emailing; project work; presentation techniques; discussing diagrams).

4 Forms of teaching:

Sem. lessons, individual and group work, etc.
Semester project (Assignment)

5 Participation requirements:

Formal:	None
Content:	English language competence: B1.2 (according to the European Reference Framework for Languages)

6 Forms of assessment:

Combination examination

7	Prerequisite for the award of credit points: 70% attendance and active participation; passed semester project and written exam
8	Application of the module (in the following study programmes) Electrical Engineering B.Eng., Engineering Computer Sciences B.Eng. and Renewable Energies B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Dr. phil. Anna Trebits
11	Other information: Literature will be announced at the beginning of the course. Textbook, additional materials, intranet self-study courses
12	Language: English

Technical English 2					FSE2
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1086	150 h	5	4th semester 6th semester	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture		0	SCH	0	h	0	h
	Sem. lessons	30 students	4	SCH	60	h	90	h
	Exercise		0	SCH	0	h	0	h
	Practical or seminar		0	SCH	0	h	0	h
	Supervised self-study	30 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

- Expertise: The students have an extended active language competence of the upper B2.2 level. They enhance their Technical English vocabulary and can combine it with expressions from Business English.
- Social competence: they develop sensitivity to differences in intercultural communication, especially in English-speaking business environments.
- Methodological competence: They are able to skim technical texts for essential information. They present them shortly and concisely, both in speaking and in writing. They establish wider contexts and make a critical assessment.
- Personal competence: They show English fluency and a pro-active approach to managing authentic English sources.

3 Contents:

- Students can actively participate in international conferences.
- They master the core terminology for dealing with problem-oriented case studies (e.g. Industry 4.0; automated systems; discussing readings and trends).
- They possess interdisciplinary skills (e.g. project management; business plan and marketing; economic sectors, manufacturing pro- cesses; pitching a technical product; conference posters; academic writing; persuasion strategies).

4 Forms of teaching:

Sem. lessons, individual and group work, etc.
Seminar project (Assignment)

5 Participation requirements:

Formal:	Modules: 1085 Technical English 1
Content:	English language competence: B2.1 (according to the European Reference Framework for Languages)

6 Forms of assessment:

Combination examination

7 Prerequisite for the award of credit points:

	70% attendance and active participation, passed semester project and written exam
8	Application of the module (in the following study programmes) Electrical Engineering B.Eng., Engineering Computer Sciences B.Eng. and Renewable Energies B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module Coordinator: Dr. phil. Anna Trebits
11	Other information: Literature will be announced at the beginning of the course. Textbook, course supplementary materials, self-study courses Study programmes in Electrical Engineering, Engineering Computer Sciences, Renewable Energies: Elective subject
12	Language: English

Theoretical Computer Science					THINF
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
1404	150 h	5	5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	30	h	45	h
	Sem. lessons	30 students	2	SCH	30	h	45	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:

- Students are able to analyse the fundamentals of formal alphabets, words, languages, grammars and the necessary operations
- They are able to classify formal languages and place them in the Chomsky hierarchy
- Students are able to explore the various types of automata, including DFAs, NFAs, pushdown automata, LBAs and Turing machines, including various forms of representation
- They are able to analyse the relationships between the different types of formal languages, grammars and automata
- Students are able to explain the basics of O-notation, space and time complexity, and reducibility
- They are familiar with worst-case complexity classes and their relationships and can use abstract analysis and examples to understand them up to the millennium problem P-NP
- Selected proofs are familiar to students; in case of constructive proofs, they can carry out the related constructions independently
- Students are able to use the acquired knowledge to evaluate algorithms

3 Contents:

- Alphabets, words, languages, grammars Regular expressions
- Chomsky hierarchy
- DFAs, NFAs, PDAs, DPDAs, LBAs, DTMs, NTMs
- O-notation
- Space and time complexity
- Worst-case complexity classes
- Many-one reductions
- The millennium P-NP problem
-

4 Forms of teaching:

Lecture, practical exercises

5 Participation requirements:

Formal:	
Content:	• Basic knowledge of computer science • Basic knowledge of analysis • Basic knowledge from the lecture “Algorithms and Data Structures”

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)

Engineering Computer SciencesComputer Sciences B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10 Module Coordinator:

Prof. Dr.-Ing. Wolfram Schenck

11	Other information:
12	Language: German

Elective Module					WM
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
9001	150 h	5	4th/5th/6th sem.	each semester	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students		SCH		h		h
	Sem. lessons	30 students		SCH		h		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		SCH		h		h
2	Learning outcomes/competences:							
3	Contents:							
4	Forms of teaching:							
5	Participation requirements:							
	Formal:							
	Content:							
6	Forms of assessment:							
7	Prerequisite for the award of credit points:							
8	Application of the module (in the following study programmes) Engineering Computer Sciences B.Eng.							
9	Importance of the grade for the final grade:							
10	Module Coordinator: Prof. Dr.-Ing. Lutz Grünwoldt							
11	Other information:							
12	Language: German							