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

Introduction to the Engineering Profession and Laboratory Operation								**ELM-1-EBL**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
1.1	**150 h**	**5**	1st sem.	Annual	Winter	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	118 h	Sem. lessons with	40	German
	Exercise	2 SCH		self-study material	16	German
	Practical / Seminar	0 SCH		Some laboratory exercises		
	Supervised self-study	16 h			40	German

2 Learning outcomes / competences

The students have an overview of fields of application, development and career prospects for electrical engineers. They are familiar with the basic concepts of the market and the organisation of an industrial company. They have an overview of the departments involved in product development and know the responsibility of the engineer in society.
They know the organisation of studies, the modules and their content links in the electrical engineering study programme and thus understand the course of study and the link to their future engineering work.
The students know the most important measuring instruments in the electrical engineering laboratory and can use them in the practicals. They know what the requirements are for a laboratory report and can prepare them independently. They have an overview of the software tools used in their studies.

3 Contents

Introduction to the professional field:
- Engineers in modern industrial companies
- Market, purchasing power, supply and demand, goods
- The industrial enterprise: Goals, competition, fields of activity, information flows
- Sectors and main activities of the engineer
- Development of components using the example of automation technology and mechatronics
- Responsibility of the engineer (ethics)

Introduction to laboratory work:
- Physical quantities, units
- Overview and use of measuring instruments
- Notes on laboratory work and report preparation
- Overview of software tools used in the study programme and use of software tools

4 Participation requirements

None

5 Form of assessment

Performance test

6 Condition for the award of credit points

Module examination pass

7 Application of the module (in the following study programmes)**:**

ELM

8 Module coordinator

Prof. Dr.-Ing. Sven Battermann

9 Other information

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Mathematics 1								**ELM-1-MA1**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
1.2	**150 h**	**5**	1st sem.	Annual	Winter	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	102 h	Sem. lessons with	40	German
	Exercise	2 SCH		self-study material	40	German
	Practical / Seminar	0 SCH				
	Supervised self-study	32 h			40	German

2 Learning outcomes / competences

The participants acquire the ability to analyse real-valued functions with confidence in order to determine arbitrary properties of interest: They obtain familiarity with common function types and the mathematical notation and have mastered calculations utilising real and complex numbers. They are able to determine the inverse function (or an appropriate local branch) and can routinely analyse rational functions in order to correctly sketch the function graph qualitatively. They are familiar with limit values of sequences and function values, utilised, for example, to determine asymptotic behaviour of functions. They are able to correctly derive real functions and can systematically utilise this knowledge to perform function analysis and curve sketching. Furthermore, they are able to linearise a given function and understand the general idea of function approximation behind this process. Finally, they master integration up to "integration based on partial fraction decomposition" and can apply integration methods in order to determine geometric area calculations.

3 Contents

Basics

- Number ranges, terminology, symbols, knowledge of basic functions
- Arithmetic of complex numbers

Analysis I

- Sequences and limits
- Real functions of one variable
  - Reverse functions
  - Analysis of rational functions
- Differential calculus of functions of one variable
  - Integral calculus of functions of one variable

4 Participation requirements

None

5 Form of assessment

Written examination

6 Condition for the award of credit points

Module examination pass

7 Application of the module (in the following study programmes)**:**

ELM

8 Module coordinator

Prof. Dr.-Ing. Tilman Hetsch

9 Other information

Participation in the preceding preparatory course and the tutorials is strongly recommended.

Physics								**ELM-1-PHY**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
1.3	**150 h**	**5**	1st sem.	Annual	Winter	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	102 h	Sem. lessons with	40	German
	Exercise	1 SCH		self-study material	40	German
	Practical / Seminar	1 SCH			16	German
	Supervised self-study	24 h			40	German

2 Learning outcomes / competences

Students understand the basic concepts, ideas and mathematical methods of classical physics. They can set up and solve equations of motion for mechanical systems. They understand the creation of images through geometric optics. They understand the principles of interference, diffraction and polarisation as a consequence of the wave nature of light. They can use physical relationships to solve technical problems. Students possess skills in simple experimentation as well as in the presentation and evaluation of measurement results.

3 Contents

Lecture/Exercise

- **Introduction to the basics of physics**:
  Converting units; scalars and vectors
  Measurement of physical quantities, measurement uncertainty and evaluation of measurement data
- **Mechanics of mass points and rigid bodies**:
  Basic concepts of movement; dynamics: Mass, momentum and force; work, energy and power; rotary motion
- **Vibrations and waves**:
  Wave theory; Mechanical waves; Forced vibrations
- **Geometric optics**:
  Light propagation; Reflection and refraction; Optical instruments
- **Wave optics**:
  Interference, diffraction, polarisation

Practical

This knowledge is rounded off in the form of a practical course with selected physical experiments from the fields of mechanics and geometric optics. The experiments are carried out and evaluated independently in small groups.

4 Participation requirements

None

5 Form of assessment

Written or performance exam

6 Condition for the award of credit points

Passed module examination and issued attendance certificate for the practical course

7 Application of the module (in the following study programmes)**:**

ELM

8 Module coordinator

Prof. Dr.-Ing. Frank Hamelmann

9 Other information

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Electrical Engineering – DC Technology								**ELM-1-GST**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
1.4	**150 h**	**5**	1st sem.	Annual	Winter	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	110 h	Sem. lessons with	40	German
	Exercise	1 SCH		self-study material	40	German
	Practical / Seminar	1 SCH			16	German
	Supervised self-study	16 h			40	German

2 Learning outcomes / competences

The students know and understand the basics of direct current technology. They can apply the common calculation methods for linear DC circuits, also with several electrical sources and loads. They are familiar with the concepts of electrical energy and power, and can apply them in circuits. They understand the concepts of analysis and application of bipoles and quadripoles. They understand the concept of linearisation of non-linear characteristics, and can calculate mixed linear-non-linear circuits.
Students know the basic properties of static and of slowly changing electric and magnetic fields.

3 Contents

Lecture/Exercise

- Basic terms, Kirchhoff's laws, basic linear circuits (two-terminal)
- Sources, internal resistance, voltage/current source transformation, power matching, efficiency
- Calculation methods for linear networks, Thévenin’s theorem, Norton equivalent
- Non-linear characteristics, linearisation, equivalent circuits
- Simple mixed linear-nonlinear circuits
- Dependent sources, quadripole parameters
- Properties of static and of slowly changing electric and magnetic fields

Practical

- Linear circuits
- Nonlinear characteristics
- Circuit calculation with the simulation tool Spice

4 Participation requirements

None

5 Form of assessment

Written examination

6 Condition for the award of credit points

Passed module examination and issued test for the practical course

7 Application of the module (in the following study programmes)**:**

ELM

8 Module coordinator

Prof. Dr.-Ing. Philipp A. Boysen

9 Other information

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Computer Science								**ELM-1-INF**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
1.5	**150 h**	**5**	1st sem.	Annual	Winter	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	102 h	Sem. lessons with	40	German
	Exercise	1 SCH		self-study material	40	German
	Practical / Seminar	1 SCH			16	German
	Supervised self-study	24 h			40	German

2 Learning outcomes / competences

The students know the basic principle of computers and can apply simple forms of programming. They know the representation of the fundamental data types of programming languages. They can programme simple tasks in a script language and thus automate work steps on the computer. They also know the basic concept of a database and can create simple data operations and queries.

3 Contents

Lecture / Exercise

- Computer basics
  - Computer architecture
  - Number systems: Decimal, dual and hexadecimal system, and conversion
  - Logical operations
  - Fundamental data types: Integers, characters, strings, floating point numbers
- Basics of programming languages
  - Basic elements – variables, branches, loops, subroutines
  - Compiled and script languages
- Algorithms and data structures
  - Algorithms, recursion
  - Flow charts
  - Lists, queues, searches, simple sorting
- Databases
  - Basics,

structure, operations/queries

Practical / Project Work

- Algorithmic programming
- Script programming
- Use of databases

4 Participation requirements

None

5 Form of assessment

Performance exam or project work or written exam

6 Condition for the award of credit points

Passed module examination and issued test for the practical course

7 Application of the module (in the following study programmes)**:**

ELM

8 Module coordinator

Prof. Dr.-Ing. Philipp A. Boysen

9 Other information

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Project Management and Scientific Work								**ELM-2-PJM**
No.	**Workload**	**Credit points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
2.1	**150 h**	**5**	2nd sem.	Annual	Summer	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	118 h	Sem. lessons with	40	German
	Exercise	2 SCH		self-study material	40	German
	Practical / Seminar	0 SCH				
	Supervised self-study	16 h			40	German

2 Learning outcomes / competences

The students understand the basic methods of working in engineering science and can apply them in the context of term paper and practical work, among other things. Students know the world of project management. They can recognise projects and distinguish them from other processes. They know success and failure factors of a project and can create a project plan with goals and deliverables as well as participate in the project itself and monitor the project progress. The students know the project steering committees and the different roles of the project participants and are able to act correctly and efficiently with them. They are able to apply basic project management methods and techniques as well as software tools to support projects.

3 Contents

Basics of project management
- Project types
- Goals and requirements
- Project participants, stakeholders
- Phases of problem solving and project implementation
- Planning, organisation and control of projects
- Use of software for project execution
- Project documentation and reporting
- Methods and techniques of project management

Methods for scientific work
- Research
- Deduction and induction
- scientific writing
- correct citation
- Term paper, Project and Bachelor Thesis Guideline

4 Participation requirements

None

5 Form of assessment

Project work

6 Condition for the award of credit points

Module examination pass

7 Application of the module (in the following study programmes)**:**

ELM

8 Module coordinator

Prof. Dr.-Ing. Oliver Wetter

9 Other information

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Mathematics 2								**ELM-2-MA2**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
2.2	**150 h**	**5**	2nd sem.	Annual	Summer	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	102 h	Sem. lessons with	40	German
	Exercise	2 SCH		self-study material	40	German
	Practical / Seminar	0 SCH				
	Supervised self-study	32 h			40	German

2 Learning outcomes / competences

The participants acquire the ability to approximate real functions by means of Taylor polynomials. They know the Taylor series of important functions and the significance of the radius of convergence. They are proficient in vector calculus, can confidently handle the basic elements (point, straight line, planes) of analytical geometry and calculate the distances and intersections of objects derived from these elements. They are familiar with the manipulation of matrices and can solve arbitrary linear systems of equations with the help of the Gaussian algorithm, non-quadratic systems included. They understand the underlying theory about the number of solutions in over-, under- and uniquely determined systems and can evaluate determinants up to Sarrus' rule. Finally, they can determine inverse matrices and use them to solve matrix equations. Furthermore, the calculus of multivariable functions is discussed in detail: In differential calculus, they can confidently calculate tangent planes, the gradient or directional derivatives and determine the location and type of critical points. With respect to multivariable integration they can select appropriate coordinate systems and solve integrals, for example, to determine areas, volumes, centres of gravity or moments of inertia.

3 Contents

Linear algebra

- Vector and matrix calculus & analytical geometry
- Linear systems of equations & inverse matrices

Analysis II

- Taylor polynomials and Taylor series for functions of single variable
- Differential calculus for multivariable functions
  - Partial derivatives, local extrema, gradients, directional derivative
- Integral calculus for multivariable functions
- Cartesian, polar, cylindrical and spherical coordinate systems

4 Participation requirements

Formal: None
Requested: Good working knowledge from the module "Mathematics 1" for Electrical Engineering

5 Form of assessment

Written examination

6 Condition for the award of credit points

Module examination pass

7 Application of the module (in the following study programmes)**:**

ELM

8 Module coordinator

Prof. Dr.-Ing. Tilman Hetsch

9 Other information

Participation in the accompanying tutorials is strongly recommended.

Electrical Engineering – AC Technology								**ELM-2-WST**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
2.3	**150**	**5**	2nd sem.	Annual	Summer	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	102 h	Sem. lessons with	40	German
	Exercise	1 SCH		self-study material	40	German
	Practical / Seminar	1 SCH			16	German
	Supervised self-study	24 h			40	German

2 Learning outcomes / competences

Students understand the law of induction and know the concept of inductance and capacitance. In addition to characteristics of alternating quantities, they understand complex alternating current calculation as well as phasor representation and can apply these to the calculation of circuits. They know the basic idea of frequency analysis, can analyse the frequency dependence of circuits and know the representation as locus curve and Bode diagram. They know symmetrical three-phase systems and can calculate with them.

3 Contents

Lecture/Exercise

- Law of induction, inductance, capacitance
- Differential equations for RC and RL circuits
- Characteristics of alternating quantities in the time domain
- Complex alternating current calculation (phasor diagrams)
- Frequency dependence of networks (transfer functions)
- Frequency analysis, spectrum
- Locus curve, Bode diagram
- Basic filter circuits and oscillating circuits
- Application of simulation tools
- Symmetrical three-phase systems

Practical course

- Magnetic induction
- Networks at variable frequency, oscillating circuits
- Transformer

4 Participation requirements

None

5 Form of assessment

Written examination

6 Condition for the award of credit points

Passed module examination and issued test for the practical course

7 Application of the module (in the following study programmes)**:**

ELM, WIM

8 Module coordinator

Prof. Dr.-Ing. Sven Battermann

9 Other information

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Programming in C								**ELM-2-PIC**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
2.4	**150 h**	**5**	2nd sem.	Annual	Summer	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	102 h	Sem. lessons with	40	German
	Exercise	1 SCH		self-study material	40	German
	Practical / Seminar	1 SCH			16	German
	Supervised self-study	24 h			40	German

2 Learning outcomes / competences

Students master all the basic techniques of programming in C and can apply them to technical and engineering problems. They can independently solve standard tasks in C both on PCs as well as on embedded systems. They know the requirements in industrial software development.

3 Contents

Lecture/Exercise

- Programming environments, compilers and debuggers
- Structure of C programmes
- Preprocessor instructions
- Input and output
- Basic data types, operations and type conversion
- Control structures and logical operations
- Functions, parameter passing methods
- Arrays and pointers
- Structures, bit fields
- Type definitions
- File processing
- Multi-file projects and libraries
- Dynamic memory allocation
- Lists, trees, sorting algorithms
- Development of product-relevant code, coding guidelines

Practical

- Programming and implementation of embedded systems
- Digital and analogue interfaces
- Timers and event handling
- User interfaces (display, buttons, LEDs)

4 Participation requirements

Formal: none
Content: Knowledge of the module “Computer Science”

5 Form of assessment

Written examination

6 Condition for the award of credit points

Passed module examination and issued test for the practical course

7 Application of the module (in the following study programmes)**:**

ELM, MBM, WIM

8 Module coordinator

Prof. Dr.-Ing. Philipp A. Boysen

9 Other information

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Digital Technology								**ELM-2-DIG**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
2.5	**150 h**	**5**	2nd sem.	Annual	Summer	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	110 h	Sem. lessons with	40	German
	Exercise	1 SCH		self-study material	40	German
	Practical / Seminar	1 SCH			16	German
	Supervised self-study	16 h			40	German

2 Learning outcomes / competences

Students will be able to explain digital technology with its various subject areas from scratch: They are able to apply the relevant number systems of digital technology. They can map logical relationships in Boolean algebra and know the calculation laws for transforming terms. They can safely use methods of systematic minimisation of Boolean functions. They have an understanding of standard digital circuits and can design logical circuits using automata theory.

3 Contents

Lecture/Exercise

- Number systems and conversions of numbers
- Boolean functions and arithmetic laws, canonical basic forms
- Logic realisations: Technologies, building blocks
- Karnaugh-Veitch diagram (KV): Structure, entry, simplifications
- Systematic minimisation
- (a)synchronous standard circuits such as counters, multiplexers, code converters
- Hazards and races, metastable states
- Flip-flops
- Automats
- Outlook for higher integrated logic

Practical course

- Logical components and their simulation
- Digital basic circuits
- Cascaded basic circuits and time effects

4 Participation requirements

None

5 Form of assessment

Written examination

6 Condition for the award of credit points

Passed module examination and issued test for the practical course

7 Application of the module (in the following study programmes)**:**

ELM, WIM

8 Module coordinator

Prof. Dr.-Ing. Oliver Wetter

9 Other information

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Mathematics 3								**ELM-3-MA3**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
3.1	**150 h**	**5**	3rd sem.	Annual	Winter	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	110 h	Sem. lessons with	40	German
	Exercise	2 SCH		self-study material	40	German
	Practical / Seminar	0 SCH				
	Supervised self-study	24 h			40	German

2 Learning outcomes / competences

Students are able to describe the motion of a material point as a parameterised path in space, and calculate and draw associated velocity and acceleration vectors. They master the calculation of curve integrals of scalar or vector-valued functions. They are able to classify ordinary differential equations (ODE) and to choose appropriate solution methods. They can confidently solve any linear ODE, as well as non-linear ODEs to which "separation of variables" or substitution methods are applicable. They are well acquainted with initial value problems of *nth* order linear ODE with constant coefficients. They know the typical steps of a modelling (derivation of variables from a physical setup, modelling as ODE, mathematical solution, interpretation of the results) by means of practical examples: "Free fall", "Population biology: logistic growth", "Free & damped oscillations of a spring-mass oscillator". They can solve non-linear ODEs of the type $y^{(n)} = f[x, y^{(n-1)}(x)]$, as well as coupled systems of two linear ODEs of 1st order. Finally, they can use combinatorics and common stochastic techniques such as basic probability calculus, probability trees, and the "hypergeometric distribution" to calculate Laplace probabilities and "conditional probabilities".

3 Contents

Stochastics
- Combinatorics & Laplace Probabilities

Multidimensional integral calculus
- Parameterised paths in space
- Curve integrals of scalar & vector-valued functions

Ordinary differential equations
- Ordinary differential equations of 1st order
- Linear differential equations of *nth* order with constant coefficients
- Systems of coupled linear DGL 2nd ord. with constant coefficients

4 Participation requirements

Formal: none
Requested: Good working knowledge from the modules "Mathematics 1" and "Mathematics 2" for Electrical Engineering

5 Form of assessment

Written examination

6 Condition for the award of credit points

Module examination pass

7 Application of the module (in the following study programmes)**:**

ELM

8 Module coordinator

Prof. Dr.-Ing. Tilman Hetsch

9 Other information

Participation in the accompanying tutorials is strongly recommended.

Passive Circuits and Components								**ELM-3-PS**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
3.2	**150 h**	**5**	3rd sem.	Annual	Winter	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	102 h	Sem. lessons with	40	German
	Exercise	1 SCH		self-study material	40	German
	Practical / Seminar	1 SCH			16	German
	Supervised self-study	24 h			40	German

2 Learning outcomes / competences

The students know passive components as well as homogeneous semiconductors and diodes. They know the physical and electrotechnical properties of the components as well as their ideal and real characteristics. The students are able to apply the mentioned components in circuits and to dimension circuits also by using simulation tools. They know transient processes as they occur during switching operations as well as passive filter circuits and the influences of the circuitry on these.

3 Contents

Lecture/Exercise

- For resistors, capacitors, coils, transformers: Physical basics, electrical behaviour incl. parasitic effects, tolerances, designs, data sheets, lifetime and thermal behaviour, circuits
- Semiconductor basics
- Homogeneous semiconductors and diodes: Physical basics, electrical behaviour, designs, data sheets and circuits
- Transient processes (switching of direct and alternating variables, saturation, inrush current)
- Passive filter circuits (input and output impedances, feedback, series connection)
- Application of simulation tools for the calculation of circuits

Practical course

- Real linear passive components
- Transient processes and homogeneous semiconductors
- Diodes

4 Participation requirements

None

5 Form of assessment

Written examination

6 Condition for the award of credit points

Passed module examination and issued test for the practical course

7 Application of the module (in the following study programmes)**:**

ELM, WIM

8 Module coordinator

Prof. Dr.-Ing. Sven Battermann

9 Other information

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Object-Oriented Programming in C++								**ELM-3-OOP**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
3.3	**150 h**	**5**	3rd sem.	Annual	Winter	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	102 h	Sem. lessons with	40	German
	Exercise	1 SCH		self-study material	40	German
	Practical / Seminar	1 SCH			16	German
	Supervised self-study	24 h			40	German

2 Learning outcomes / competences

The students know and understand the principles of object-oriented programming and can apply these independently in the C++ language to solve typical technical and engineering problems. They know typical standard design patterns used in the design of object-oriented architectures and are fundamentally familiar with the object-oriented modelling language UML.

3 Contents

Lecture/Exercise

- Overloading, default parameters
- References
- Classes, methods, objects
- Constructors, destructors, shallow and deep copy
- Dynamic memory allocation
- Inheritance, multiple inheritance, interface concept, class hierarchy
- Virtual functions, dynamic binding, polymorphism
- Global Methods, Friends
- Streams, name ranges
- Exception handling
- Generic programming / templates
- Working with standard libraries
- Introduction to design patterns
- Introduction to the modelling language UML

Practical course

- Working with class libraries
- Class and method development
- GUI development

4 Participation requirements

Formal: none
Content: Knowledge of the "Computer Science" and "Programming in C" modules

5 Form of assessment

Written examination

6 Condition for the award of credit points

Passed module examination and issued test for the practical course

7 Application of the module (in the following study programmes)**:**

ELM, MBM, WIM

8 Module coordinator

Prof. Dr.-Ing. Philipp A. Boysen

9 Other information

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Signals and Systems								**ELM-3-SUS**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
3.4	**150 h**	**5**	3rd sem.	Annual	Winter	1 sem.	Compulsory/ compulsory elective	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	118 h	Sem. lessons with	40	German
	Exercise	2 SCH		self-study material	40	German
	Practical / Seminar	0 SCH				
	Supervised self-study	16 h			40	German

2 Learning outcomes / competences

Students are familiar with the concept of a signal and the representation of signals in the time and frequency domain. They master the frequency analysis of signals by the Fourier transform and can apply it in a practical environment. They know the most important properties and characterisations of linear time-invariant systems. The students know the solution of the system-describing differential equation of linear time-invariant systems by means of Laplace transformation and are able to apply it to systems. They also know the properties of filter circuits and can design them themselves. They know the basic approaches to the treatment of discrete-time signals and systems.

3 Contents

Lecture/Exercise

- Descriptions of signals in the time and frequency domain
- Continuous- and discrete-time signals and systems
- Fourier series, Fourier transform, Laplace transform
- Linear time invariant systems
- Transfer function, system response, convolution, causality and stability, PZ diagrams
- Analogue filters: Properties, comparison, realisations (e.g. Bessel, Butterworth, Chebyshev filters)
- Discrete-time signals: Sampling, Discrete Fourier Transform, z-Transform
- Basic concepts of digital filters

4 Participation requirements

None

5 Form of assessment

Written examination

6 Condition for the award of credit points

Module examination pass

7 Application of the module (in the following study programmes)**:**

ELM, WIM

8 Module coordinator

Prof. Dr.-Ing. Sven Battermann

9 Other information

This module is a compulsory module for the specialisation in IST.

Introduction to Electromagnetic Field Theory								**ELM-3-FEL**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
3.5	**150 h**	**5**	3rd sem.	Annual	Winter	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	102 h	Sem. lessons with	40	German
	Exercise	1 SCH		self-study material	40	German
	Practical / Seminar	1 SCH			16	German
	Supervised self-study	24 h			40	German

2 Learning outcomes / competences

Students master the integral description of static, stationary and slowly changing electric and magnetic fields and of electric flow fields as well as their interrelationships. They are able to calculate these fields for simple arrangements and they can answer application-related questions about these fields.

3 Contents

Lecture/Exercise

- Vector fields and the gradient
- Vector analytical description:
  - Static electric field, charge, potential and voltage, vacuum and dielectrics, capacitance
  - Stationary electric flow field, material interfaces
  - Static magnetic field, magnetic materials, Ampère-Maxwell law, magnetic circuit, inductivity
  - Relationship between magnetic fields and moving electric charges / currents
  - Faraday's law
- Outlook: Time-variant fields, skin effect

Practical courses

- Electric field and gradient
- Magnetic field
- Simulation, visualisation of fields

4 Participation requirements

None

5 Form of assessment

Written examination

6 Condition for the award of credit points

Passed module examination and issued test for the practical course

7 Application of the module (in the following study programmes)**:**

ELM

8 Module coordinator

Prof. Dr.-Ing. Philipp A. Boysen

9 Other information

This module is a compulsory module for the specialisation in IST.

Project in Industry 1								**ELM-4-UP1**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
4.1	**150 h**	**5**	4th sem.	Annual	Summer	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Work-related project	as required	150 h	Work-related module	Individual work / Faculty tutoring	German (English possible after consultation)

2	**Learning outcomes / competences** The students are able to mirror theoretical references of electrical engineering and information technology to fields of application in practice. They can recognise and analyse typical engineering problems and independently develop solution options for them. In the work-related modules, the students acquire the ability to connect and reflect on the "world of practice" and the "world of science".
3	**Contents** The topics to be worked on are related to engineering and/or business administration and are oriented towards the module contents of the curriculum. The topic is agreed individually between the student and the faculty tutors in the company and the university.
4	**Participation requirements** Formal: none Content: Knowledge from the module "Project Management and Scientific Work"
5	**Form of assessment** Term paper
6	**Condition for the award of credit points** Module examination pass
7	**Application of the module** (in the following study programmes)**:** ELM
8	**Module coordinator** All teaching staff
9	**Other information** -

Power Electronics								**ELM-4-LE**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
4.2	**150 h**	**5**	4th sem.	Annual	Summer	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	102 h	Sem. lessons with	40	German
	Exercise	1 SCH		self-study material	40	German
	Practical / Seminar	1 SCH			16	German
	Supervised self-study	24 h			40	German

2 Learning outcomes / competences

Students know and understand the special aspects, concepts and methods of power electronics. They know the components used in power electronics with their relevant properties for this application. They can characterise the signal characteristics generated by switching processes, can determine the switching stress of power semiconductors and dimension zero-current/zero-voltage switching and driver circuits. They know and understand DC chopper-converters, single-phase and multi-phase DC, AC/AC-AC converters and inverters. They can analyse harmonics and AC line harmonics.

3 Contents

Lecture/Exercise

- Balanced and unbalanced three-phase systems
- Switching operations on passive components
- Description of non-sinusoidal signal characteristics, fundamental and harmonics
- Components of power electronics with properties and data sheets:
  Diodes, bipolar transistors, field-effect transistors, IGBTs, thyristors, etc.
- Switching load, cooling, zero-current/zero-voltage switching, driver circuits
- DC chopper
- H-bridge circuit
- Multiphase rectifiers, inverters and converters
- Harmonics and AC line

Practical course

- Three-phase current and power measurement
- DC chopper
- Switching power supplies or AC inverters

4 Participation requirements

Formal: None
Content: Knowledge of complex alternating current calculation and the contents of the module "Passive Circuits and Components"

5 Form of assessment

Written examination

6 Condition for the award of credit points

Passed module examination and issued test for the practical course

7 Application of the module (in the following study programmes)**:**

ELM, WIM

8 Module coordinator

Prof. Dr.-Ing. Philipp A. Boysen

9 Other information

-

Electrical Power Engineering								**ELM-4-EET**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
4.3	**150 h**	**5**	4th sem.	Annual	Summer	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	118 h	Sem. lessons with	40	German
	Exercise	2 SCH		self-study material	40	German
	Practical / Seminar	0 SCH				
	Supervised self-study	16 h			40	German

2 Learning outcomes / competences

Students have a good overview of the range of topics in electrical power engineering. They know the methods and the operating equipment for the generation and distribution of electrical energy. They can apply the most important calculation methods for processes in electrical networks, they are familiar with basic insulation, earthing and protection measures, and they have an overview of the aspects of insulation and high-voltage technology relevant to power engineering.

3 Contents

Lecture/Exercise

- Generation of electrical energy: Conventional power plants, renewable energy sources
- Three-phase system: Earthing systems, function, neutral point handling, fault cases
- Electric equipment: Overhead lines, cables, transformers, switchgear and switching stations
- Nets: Structure, operating modes, power flow control
- Calculation method: Symmetrical components, short circuits, earth faults, power flow
- Harmonics
- Insulation technology and testing methods
- Generation and measurement of high voltage
- Earthing and protective measures, selectivity

4 Participation requirements

None

5 Form of assessment

Written examination

6 Condition for the award of credit points

Module examination pass

7 Application of the module (in the following study programmes)**:**

ELM, WIM

8 Module coordinator

Prof. Dr.-Ing. Philipp A. Boysen

9 Other information

-

Control and Automation Technology								**ELM-4-SA**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
4.4	**150 h**	**5**	4th sem.	Annual	Summer	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	102 h	Sem. lessons with	40	German
	Exercise	1 SCH		self-study material	40	German
	Practical / Seminar	1 SCH			16	German
	Supervised self-study	24 h			40	German

2 Learning outcomes / competences

The students know numerous application examples of automation technology and have internalised the system behind it. They have a sound knowledge of the design and configuration of automation systems using classic connection-programmed and digital microcontroller and PLC technology and can apply this to automation projects. They can explain the networking of automation components with each other and with control rooms. In sum, students are thus able to evaluate and design basic automation systems.

3 Contents

Lecture/Exercise

- Automation systems at a glance
- Design and simulation
- Interfaces to the process, sensors and actuators
- Function and structure of programmable logic controllers
- Programming the PLC
- Automation examples
- Buses and peripheral systems
- Process visualisation and modern engineering tools
- Trends in automation systems (real-time capability, networking)

Practical: Assembly Line

- Commissioning of hardware and manual functions, visualisations
- Operating modes and step chain with sequential process
- Step chains with parallel processes

4 Participation requirements

None

5 Form of assessment

Written examination

6 Condition for the award of credit points

Passed module examination and issued test for the practical course

7 Application of the module (in the following study programmes)**:**

ELM

8 Module coordinator

Prof. Dr.-Ing. Oliver Wetter

9 Other information

-

Embedded Systems								**ELM-4-ES**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
4.5	**150 h**	**5**	4th sem.	Annual	Summer	1 sem.	Compulsory/ compulsory elective	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	102 h	Sem. lessons with	40	German
	Exercise	1 SCH		self-study material	40	German
	Practical / Seminar	1 SCH			16	German
	Supervised self-study	24 h			40	German

2 Learning outcomes / competences

Students understand the basic development methods for embedded systems and can apply them to practical problems. They know the external and internal structure of processors and can explain different hardware architectures for embedded systems. They are proficient in hardware-related programming, code documentation and version control as well as approaches to testing embedded systems. Furthermore, they are familiar with the structure, components and principles of real-time operating systems.

3 Contents

Lecture/Exercise

- Introduction and overview
- Processors of different performance classes and types
- Processor structure, ALU, programme logic, programme and data memory
- Peripheral blocks (analogue and digital IO, timers, interfaces, interrupt controller, EEPROM)
- Hardware-related programming of the periphery in assembler and C
- Debugging, In-Circuit Debugging
- Code documentation and version control systems
- Layer and abstraction
- Structure of real-time operating systems (scheduler, tasks and concurrency, inter-process communication)

Practical

- Commissioning of an embedded system
- Programming and operation of serial interfaces
- Programming in a real-time operating system

4 Participation requirements

Formal: none
Content: Knowledge of algorithms, information representation, data structures, automata and mastery of the programming language C

5 Form of assessment

Performance test

6 Condition for the award of credit points

Module examination pass

7 Application of the module (in the following study programmes)**:**

ELM, WIM

8 Module coordinator

Prof. Dr.-Ing. Oliver Wetter

9 Other information

This module is a compulsory module for the specialisation in IST.

Communication Technology								**ELM-4-KT**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
4.6	**150 h**	**5**	4th sem.	Annual	Summer	1 sem.	Compulsory/ compulsory elective	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	110 h	Sem. lessons with	40	German
	Exercise	1 SCH		self-study material	40	German
	Practical / Seminar	1 SCH			16	German
	Supervised self-study	16 h			40	German

2 Learning outcomes / competences

Students are familiar with the basic structure of communication systems. They know the most important properties of digital transmission systems and of signal transmission and are able to apply them to practical problems. They know and understand the terms and contexts of information theory relevant to communication systems.

3 Contents

Lesson/Exercise

- Digital transmission
  - Propagation of signals on lines; characteristic impedance and reflection
  - Analogue modulation methods
  - Digital modulation methods
- Information theory
  - Information, entropy, redundancy
  - Channel capacity
  - Source and channel coding, codes, error detection and correction
- Digital communication systems
  - Serial communication
  - Buses, protocols
  - Networks, OSI model
- Sampling/quantisation/ADC, DAC

Practical course

- Analogue modulation / mixer
- Serial communication
- Buses

4 Participation requirements

None

5 Form of assessment

Written examination

6 Condition for the award of credit points

Passed module examination and issued test for the practical course

7 Application of the module (in the following study programmes)**:**

ELM, WIM

8 Module coordinator

Prof. Dr.-Ing. Philipp A. Boysen

9 Other information

This module is a compulsory module for the specialisation in IST.

Project in Industry 2								**ELM-5-UP2**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
5.1	**150 h**	**5**	5th sem.	Annual	Winter	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Work-related project	as required	150 h	Work-related module	Individual work / Faculty tutoring	German (English possible after consultation)

2 Learning outcomes / competences

The students are able to mirror theoretical references of electrical engineering and information technology to fields of application in practice. They can recognise and analyse typical engineering problems and independently develop solution options for them. In the work-related modules, the students acquire the ability to connect and reflect on the "world of practice" and the "world of science".

3 Contents

The topics to be worked on are related to engineering and/or business administration and are oriented towards the module contents of the curriculum. The topic is agreed individually between the student and the faculty tutors in the company and the university.

4 Participation requirements

Formal: none
Content: Knowledge from the module "Project Management and Scientific Work"

5 Form of assessment

Term paper

6 Condition for the award of credit points

Module examination pass

7 Application of the module (in the following study programmes)**:**

ELM

8 Module coordinator

All teaching staff

9 Other information

-

Industrial Management								**ELM-5-IBL**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
5.2	**150 h**	**5**	5th sem.	Annual	Winter	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	118 h	sem. lessons	40	German
	Exercise	2 SCH		exercises, case studies	40	German
	Practical / Seminar	–				
	Supervised self-study	16 h		self-study materials		German

2 Learning outcomes / competences

The students have substantiated knowledge and awareness of economic thinking and acting in industrial companies and can apply this in their studies and in practice. They are able to

- identify and place essential business management aspects, interrelationships, questions and problems within both the economic and engineering context.
- conduct targeted research based on this.
- process business management questions and problems methodically adequately.
- communicate appropriately on business topics in an interdisciplinary manner.

3 Contents

Lecture/Exercise

- Fundamentals of Industrial Enterprises in the Economic System
- Management
- Management Accounting, Controlling
- Industrial Organisation
- Product Development and Marketing
- Production and Logistics

4 Participation requirements

None

5 Form of assessment

Written examination

6 Condition for the award of credit points

Module examination pass

7 Application of the module (in the following study programmes)**:**

ELM

8 Module coordinator

Prof. Dr. rer. pol. Christoph v. Uthmann

9 Other information

-

Analogue Electronics								**ELM-5-AE**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
5.3	**150 h**	**5**	5th sem.	Annual	Winter	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	102 h	Sem. lessons with	40	German
	Exercise	1 SCH		self-study material	40	German
	Practical / Seminar	1 SCH			16	German
	Supervised self-study	24 h			40	German

2 Learning outcomes / competences

This module enables students to understand and apply active components (bipolar junction and field effect transistors, operational amplifiers). The students know the physical background of circuits and can explain their electrotechnical properties as well as ideal and real expressions. They can analyse and assess given circuits from the small signal range and at the interface to digital electronics and dimension basic circuits themselves or make statements about their performance.

3 Contents

Lecture/Exercise Transistors:

- Bipolar transistor: Physical basics, electrical behaviour
- Ebers-Moll and Gummel-Poon equivalent circuit diagram
- FET: with insulated gate (IGFETs) and with non-insulated gate (JFETs), equivalent circuit diagrams
- Large and small signal behaviour, characteristic diagrams, designs, data sheets
- Dimensioning and analysis of circuits Operational amplifiers:
- Basic terms and electrical properties, data sheets
- Static and dynamic behaviour, frequency response, stability, slew rate
- Negative feedback
- Inverting and non-inverting amplifier, instrumentation amplifier, comparator, etc.
- Dimensioning and analysis of circuits Transition to digital circuits:
- Logic families
- Interfacing from and to digital circuits

Practical course

- Bipolar transistors / field effect transistors / operational amplifiers

4 Participation requirements

None

5 Form of assessment

Written examination

6 Condition for the award of credit points

Passed module examination and issued test for the practical course

7 Application of the module (in the following study programmes)**:**

ELM

8 Module coordinator

Prof. Dr.-Ing. Oliver Wetter

9 Other information

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Feedback Control Systems								**ELM-5RT**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
5.4	**150 h**	**5**	5th sem.	Annual	Winter	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	110 h	Sem. lessons with	40	German
	Exercise	1 SCH		Self-study material	40	German
	Practical / Seminar	1 SCH			16	German
	Supervised self-study	16 h			40	German

2 Learning outcomes / competences

The students understand the basic terms, ideas and methods of control engineering and know the structure and mode of operation of technical and non-technical feedback control loops. They can analyse real systems, transfer them into technical sketches and diagrams as well as into signal flow graphs and transfer functions. They can identify controlled systems, design standard linear control loops and design simple controllers to match the real systems and simulate the control system.

3 Contents

Lecture/Exercise

- Classification of technical and non-technical processes
- Description of the static and dynamic behaviour
- Creation of a mathematical model (DGL, transfer function)
- Electrical-physical modelling and simulation
- Properties of elementary transmission elements
- Analysis of control systems in the time and frequency domain
- Requirements for a feedback control loop
- Dimensioning of linear regulators
- Stability definitions and corresponding criteria

Practical

- Structural analysis of vibrating systems
- System identification of an electrical system
- Modelling, measurement and control of a temperature path

4 Participation requirements

None

5 Form of assessment

Written examination

6 Condition for the award of credit points

Passed module examination and issued test for the practical course

7 Application of the module (in the following study programmes)**:**

ELM

8 Module coordinator

Prof. Dr.-Ing. Oliver Wetter

9 Other information

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Measurement and Sensor Technology								**ELM-5-MS**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
5.5	**150 h**	**5**	5th sem.	Annual	Winter	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	102 h	Sem. lessons with	40	German
	Exercise	1 SCH		Self-study material	40	German
	Practical / Seminar	1 SCH			16	German
	Supervised self-study	24 h			40	German

2 Learning outcomes / competences

Students have an overview of the unit system and the embodiment of units and the authorities involved in them. Students know the physical measurement principles used to measure electrical and non-electrical quantities. They know measurement deviations, metrological statistics as well as distribution functions and regression. This enables them to set up measurement systems, analyse measurement data and use it to solve specific measurement tasks in practice.

3 Contents

Lecture/Exercise

- SI units, standards, standardisation organisations
- Characteristics of measurement signals
- Measurement of electrical and non-electrical quantities
- Requirements for sensors and measuring systems (measuring chains)
- Measurement deviations, measurement statistics and error propagation
- Distribution functions (normal distribution, t-distribution, quantiles)
- Regression
- Analogue-digital conversion (time- and value-discrete signals)

Practical

- Application and investigation of sensors for measuring non-electrical quantities in various laboratory experiments
- Remote control of measuring instruments and remote data acquisition

4 Participation requirements

None

5 Form of assessment

Written examination

6 Condition for the award of credit points

Passed module examination and issued test for the practical course

7 Application of the module (in the following study programmes)**:**

ELM

8 Module coordinator

Prof. Dr.-Ing. Sven Battermann

9 Other information

-

Applied Information Technology Project								**ELM-5-AIT**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
5.6	**150 h**	**5**	5th sem.	Annual	Winter	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	110 h	Sem. lessons with	40	German
	Exercise	0 SCH		self-study material		
	Practical / Seminar	1 SCH			40	German
	Supervised self-study	24 h			40	German

2	**Learning outcomes / competences** Students can grasp current and, if necessary, interdisciplinary problems in engineering research and practice, divide them into meaningful sections and solve them. They are able to work in a team and can connect the scientific research approach with the practical world. Students can apply theoretical knowledge already acquired and to be acquired to concrete problems. In doing so, they also deepen the necessary competence for knowledge transfer within the group.
3	**Contents** The content is based on classical or current engineering topics from the field of information technology. Students use and expand the knowledge they have acquired so far in theory and practice and combine the scientific approach with a complex practical task. The topic is announced by the respective subject supervisors at the beginning of the semester.
4	**Participation requirements** None
5	**Form of assessment** Project work
6	**Condition for the award of credit points** Module examination pass
7	**Application of the module** (in the following study programmes)**:** ELM
8	**Module coordinator** All teaching staff
9	**Other information** This module is a compulsory module for the specialisation in IST.

Project in Industry 3								**ELM-6-UP3**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
6.1	**150 h**	**5**	6th sem.	Annual	Summer	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Work-related project	as required	150 h	Work-related module	Individual work / Faculty tutoring	German (English possible after consultation)

2 Learning outcomes / competences

The students are able to mirror theoretical references of electrical engineering and information technology to fields of application in practice. They can recognise and analyse typical engineering problems and independently develop solution options for them. In the work-related modules, the students acquire the ability to connect and reflect on the "world of practice" and the "world of science".

3 Contents

The topics to be worked on are related to engineering and/or business administration and are oriented towards the module contents of the curriculum. The topic is agreed individually between the student and the faculty tutors in the company and the university.

4 Participation requirements

Formal: none
Content: Knowledge from the module "Project Management and Scientific Work"

5 Form of assessment

Term paper

6 Condition for the award of credit points

Module examination pass

7 Application of the module (in the following study programmes)**:**

ELM

8 Module coordinator

All teaching staff

9 Other information

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Technical English								**ELM-6-TEN**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
6.2	**150 h**	**5**	6th sem.	Annual	Summer	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	118 h	Sem. lessons with	40	English
	Exercise	2 SCH		self-study material	40	English
	Practical / Seminar	0 SCH				
	Supervised self-study	16 h			40	English

2 Learning outcomes / competences

Students can understand and summarise English texts and documents related to electrical engineering. They are able to use English technical vocabulary in their profession. They can communicate with colleagues in technical meetings in English and make telephone calls in English. They can write simple documents in English on specialised topics.

3 Contents

Technical terms and communication (in selected subject areas):

- Company and product description
- Professions and tasks in electrical engineering
- Technical building installation
- PLC technology
- Energy and environment
- Electronic components and sensors
- Measuring and testing technology
- Assembly and commissioning abroad

4 Participation requirements

None

5 Form of assessment

Written examination

6 Condition for the award of credit points

Module examination pass

7 Application of the module (in the following study programmes)**:**

ELM

8 Module coordinator

Cathrine Stones

9 Other information

-

Applied Science Project								**ELM-6-PAW**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
6.3	**150 h**	**5**	6th sem.	Annual	Summer	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	118 h	Project	16	German
	Exercise	0 SCH				
	Practical / Seminar	2 SCH			16	German
	Supervised self-study	0 h				

2	**Learning outcomes / competences** The students can grasp current and, if necessary, interdisciplinary problems of business administration and/or engineering research and practice, divide them into meaningful sections and solve them. They are able to work in a team and can connect the scientific research approach with the practical world. Students can apply theoretical knowledge already acquired and to be acquired to concrete problems. They also learn the necessary skills for knowledge transfer within the group.
3	**Contents** The content is based on classical or current engineering and/or business topics. The students use the knowledge they have acquired so far in theory and practice and combine the scientific approach with a complex practical task. The topic is announced by the respective subject supervisor at the beginning of the semester.
4	**Participation requirements** None
5	**Form of assessment** Project work
6	**Condition for the award of credit points** Module examination pass
7	**Application of the module** (in the following study programmes)**:** Interdisciplinary/cross-curricular use – ELM, MBM, WIM
8	**Module coordinator** All teaching staff
9	**Other information** -

Systems Engineering, Standards and Functional Safety								**ELM-6-SNS**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
6.4	**150 h**	**5**	6th sem.	Annual	Summer	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	118 h	Sem. lessons with	40	German
	Exercise	2 SCH		self-study material	40	German
	Practical / Seminar	0 SCH				
	Supervised self-study	16 h			40	German

2 Learning outcomes / competences

With systems engineering, students can create a system plan for a product. They can evaluate the applicability of processes, procedures and methods and apply them to practical tasks. Students are familiar with the procedures and standards to be applied in the design of safety-critical systems and components. They can calculate parameters for safety-related systems and evaluate the influence of measures in development.

3 Contents

Lecture/Exercise

- Definitions of functional safety terms, areas of application
- Standards and guidelines
- Life cycle phases of technical systems
- Methods for the analysis, design and drafting of safety-critical systems and components
- Determination of failures and diagnostic measures (failure rates, MTBF, FMEA analysis)
- Calculation of the parameters of safety-related calculations
- Hardware fault tolerance and architectures
- V-model in development
- Software design and testing
- Functional Safety Management
- Creation and review of specifications, requirements tracking
- Requirements for bus systems in functional safety technology

4 Participation requirements

None

5 Form of assessment

project work

6 Condition for the award of credit points

Module examination pass

7 Application of the module (in the following study programmes)**:**

ELM, WIM, MBM

8 Module coordinator

Prof. Dr.-Ing. Sven Battermann

9 Other information

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Electrical Drives								**ELM-6-EA**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
6.5	**150 h**	**5**	6th sem.	Annual	Summer	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	102 h	Sem. lessons with	40	German
	Exercise	1 SCH		self-study material	40	German
	Practical / Seminar	1 SCH			16	German
	Supervised self-study	24 h			40	German

2 Learning outcomes / competences

The students can explain problems in electrical drive technology. They understand the kinematics and dynamics of drive systems. They know and understand the components of electrical drive systems, from the machine types to the power circuits of DC chopper-converters, inverters and servo drives. The students know numerous details and have internalised the interaction of the components and subsystems mentioned. In sum, they can thus use electric drive systems and also design them in parts.

3 Contents

Lecture/Exercise

- Basics of mechanics and dynamics, rotatory and linear
- Direct current machines
- Transformers
- Synchronous machines
- Asynchronous machines
- Small and special machines
- Inverters
- Drive control
- Efficiency and electrical operating conditions

Practical

- Synchronous machines
- Asynchronous machines
- DC machines, control

4 Participation requirements

Formal: none

Content: Knowledge of complex-valued AC calculation, physics and electrical engineering basics

5 Form of assessment

Written examination

6 Condition for the award of credit points

Passed module examination and issued test for the practical course

7 Application of the module (in the following study programmes)**:**

ELM, MBM, WIM

8 Module coordinator

Prof. Dr.-Ing. Philipp A. Boysen

9 Other information

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Bachelor Thesis								**ELM-7-BAC**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
7.1	**360 h**	**12**	7th sem.		Winter	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Bachelor thesis	According to need	360 h	Bachelor thesis	Individual work / Faculty tutoring	German (English possible after consultation)

2	**Learning outcomes / competences** With the bachelor thesis, students demonstrate that they are capable of independently working on a practice-oriented task from the respective subject area, both in its subject-specific details and in the interdisciplinary contexts, according to scientific methods within a specified period of time.
3	**Contents** • Thesis according to topic • Written elaboration
4	**Participation requirements** See Section 22 SPO ELM
5	**Form of assessment** Bachelor thesis
6	**Condition for the award of credit points** Bachelor thesis pass
7	**Application of the module** (in the following study programmes)**:** ELM
8	**Module coordinator** All teaching staff
9	**Other information** -

Colloquium								**ELM-7-KOL**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
7.2	**90 h**	**3**	7th sem.		Winter	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Colloquium	According to need	90 h	Lecture and Disputation	Individual work / Faculty tutoring	German (English possible after consultation)

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 assessing its significance for practice.

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 Participation requirements

See Section 24 SPO ELM

5 Form of assessment

Oral examination

6 Condition for the award of credit points

Module examination pass

7 Application of the module (in the following study programmes)**:**

ELM

8 Module coordinator

All teaching staff

9 Other information

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Electromagnetic Compatibility and High Frequency Technology								**ELM-7-EMV**
No.	**Workload**	**Credit Points**	**Study semester**	**Frequency**	**Sem.**	**Duration**	**Type**	**Q level**
7.3	**150 h**	**5**	7th sem.	Annual	Winter	1 sem.	Compulsory	BA

1	**Course type**	**Contact hours**	**Self-study**	**Forms of teaching (forms of learning)**	**Planned group size**	**Language**
	Lecture	2 SCH	102 h	Sem. lessons with self-study material	40	German
	Exercise	1 SCH			40	(English possible after consultation)
	Practical / Seminar	1 SCH			16	
	Supervised self-study	24 h			40	

2 Learning outcomes / competences

The students are familiar with the line-guided and field-guided propagation of TEM waves and can calculate reflections on lines. When developing systems, they consider the interference coupling models of EMC and are able to apply the typical protective measures for an EMC-compliant circuit and PCB design. They have an overview of the standards to be complied with and know the required measurement technology and necessary tests. They have an overview of antenna technology and are able to use software for field calculation of simple problems

3 Contents

Lecture/Exercise:

- TEM waves in conductors (line theory, reflection)
- TEM waves in free space (wave propagation)
- Maxwell's equations, proximity effect, skin effect
- Antenna technology (design, radiation patterns, footpoint impedance)
- Interference coupling models
- Shielding in the HF and LF range / filter measures
- EMC measures in circuit diagram and PCB design
- Legal requirements and standards
- Metrology and measurement methods

Practical course

- Numerical field calculation for antennas
- Numerical calculation of surface currents on circuit boards
- Tests according to EMC standards

4 Participation requirements

None

5 Form of assessment

Performance exam or project work or term paper

6 Condition for the award of credit points

Passed module examination and issued test for the practical course

7 Application of the module (in the following study programmes)**:**

ELM, WIM

8 Module coordinator

Prof. Dr.-Ing. Sven Battermann

9 Other information

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