Module Guide

Electrical Engineering and Information Technology

Faculty Electrical Engineering and Media Technology

Examination regulations 01.01.2020

Date: Friday 07.10.2022 08:45

ET-01 MATHEMATICS 1

Module code	ET-01
Module coordination	Prof. Dr. Reinhard Schlosser
Course number and name	ET 1101 Mathematics 1
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	8
ECTS	9
Workload	Time of attendance: 120 hours self-study: 150 hours Total: 270 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	9/210
Language of Instruction	German

Module Objective

Primary learning objective: Students should be capable of applying mathematical concepts and methods to technical tasks in both their studies and later in their professional lives.

Students will acquire the following competencies: They have a working knowledge of symbolic fractions (equivalent fractions, distributive property, etc.). They are able to solve basic geometric tasks such as distance between point-line, point-plane, and line-line; and intersection angle of line-line, line-plane using vectors. They will have a good command of calculations with complex numbers; in particular, of conversion into various forms (cartesian, polar, exponential). Thus they are capable of applying the complex alternating current calculation. They are familiar with the definitions and definition areas, value areas, special function values, important calculation rules, and areas of differentiability of the basic functions (x^?, sin, cos, tan, cot, arcsin, arccos, arctan, arccot, sinh, cosh, tanh, coth, arsinh, arcosh, artanh, arcoth, exp, ln). In particular, they are able to sketch the appropriate graph. They are familiar with the definition of derivation and its physical, geometrical and analytical significance. They are familiar with the rules of differentiation and can apply them to expressions which are built up of elementary functions. They are familiar with basic integrals and are able to apply integration through substitution and partial integration to simple cases. They can apply integral calculation to geometric or physical questions. They are able

to examine linear systems of equations with the help of Gaussian elimination. They are capable of utilising matrix calculus.

Applicability in this and other Programs

With regards to bachelor degree course: C02, C04, C06, C10, C11, C12, C13, C15, C16, C17, C18, C19, C20, C27, C28, C31, C33, C34, C35, C36, C37, C38, C39, C40, C41, C42, C43, C44, C45, C46, C47, C48, C49, C50

With regards to other degree courses: none

Entrance Requirements

Formally: none

In terms of content: none

Learning Content

1. **Numbers and Vectors**
    - 1.1. Sets and Transformations
    - 1.2. Real Numbers
    - 1.3. Planes
    - 1.4. Vectors
    - 1.5. Products
    - 1.6. Lines and Planes
    - 1.7. Complex Numbers
2. **Functions, Tolerances, Constants**
    - 2.1. Functions (Basic Concepts)
    - 2.2. Polynomials and Rational Functions
    - 2.3. Trigonometric Functions
    - 2.4. Sequences and Limits of Sequences
    - 2.5. Calculation Rules for Limits of Sequences and Convergence Tests
    - 2.6. Limits of Functions
    - 2.7. Continuous Functions
3. **Differentiation**

3.1. The Derivation of a Differentiable Function

3.2. Applications of Differentiation

3.3. Inverse Functions

3.4. The Exponential and Logarithm Function

4. **Integration**

4.1. The Definite Integral

4.2. Rules of Integration

4.3. Integration of Rational Functions

4.4. Improper Integrals

5. **Linear Algebra**

5.1. Systems of Equations and Matrices

5.2. Matrix Multiplication

5.3. Determinants

Teaching Methods

Seminaristic lessons. In class, the contents are worked out with the involvement of the students, documented with the help of a gap script, illustrated with examples and flanked and practiced with comprehension questions and 5-minute exercises. Exercises, controlled questions. hints and sample solutions help the student to rework and acquire the contents. Application-oriented examples and tasks demonstrate the usefulness of mathematical concepts and methods and build bridges to the foundation of electrical engineering, physics and electrodynamics.

Recommended Literature

K. Meyberg / P. Vachenauer: Höhere Mathematik I, 6. Auflage. Springer Verlag, Berlin 2001.

ET-02 MATHEMATICS 2

Module code	ET-02
Module coordination	Prof. Dr. Reinhard Schlosser
Course number and name	ET 2101 Mathematics 2
Lecturer	Prof. Dr. Reinhard Schlosser
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	6
ECTS	7
Workload	Time of attendance: 90 hours self-study: 120 hours Total: 210 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	6/210
Language of Instruction	German

Module Objective

Primary learning objective: Students should be capable of applying mathematical concepts and methods to technical tasks in both their studies and later in their professional lives.

In addition, students will acquire the following competencies:
They are able to apply differential and integral calculations to spatial curves, areas and ranges. In particular, they are capable of determining tangents and tangent planes. They are familiar with the definition of gradient, divergence, and rotation and their geometric as well as physical significance. They are thereby capable of applying these concepts in more advanced courses (electrodynamics).

Applicability in this and other Programs

In regards to this bachelor degree course: C11, C12, C13, C17, C18, C19, C27, C28, C31, C33, C34, C37, C38, C39, C40, C41, C42, C43, C45, C46, C48, C50

In regards to other degree courses: none

Entrance Requirements

Formally: none

In terms of content: C01, C03, C05

Learning Content

1. **Linear Algebra**
    - 1.1. Linear Functions and Characteristic Values
    - 1.2. Symmetric Matrices and Quadratic Forms
2. **Functions of Multiple Variables: Differentiation**
    - 2.1. Curves in IRn
    - 2.2. Real-valued Functions with Multiple Real Variable
    - 2.3. Applications of Differentiation
    - 2.4. Functions with Vectorial Values
3. **Funktionen of Multiple Variables: Integration**
    - 3.1. Parameter Integrales
    - 3.2. Curve Integrals
    - 3.3. Integration over Flat Ranges
    - 3.4. Integration over Areas in Space
    - 3.5. Integration over 3-Dimensional Spaces

Teaching Methods

Seminaristic lessons. In class, the content is developed with the involvement of the students, documented with the help of a gap script, illustrated by examples and flanked and practiced by comprehension questions and 5-minute tasks. Exercises, control questions, tips and sample solutions serve the student for reworking and appropriation of the contents. Application-oriented examples and tasks demonstrate the usefulness of mathematical concepts and methods and build bridges to the foundations of electrical engineering, physics and electrodynamics.

Recommended Literature

K. Meyberg / P. Vachenauer: Höhere Mathematik I, 6. Auflage. Springer Verlag, Berlin 2001.

ET-03 PHYSICS 1

Module code	ET-03
Module coordination	Prof. Dr. Johann Plankl
Course number and name	ET 1102 Physics 1
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	5
ECTS	6
Workload	Time of attendance: 75 hours self-study: 105 hours Total: 180 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	6/210
Language of Instruction	German

Module Objective

Students essentially deal with methods of classical physics of a point mass. They learn the necessary steps to work out independent solutions for corresponding problems in the field of engineering, whereby they are especially enabled to critically question the selection of the corresponding methods and calculation procedures.

The students get to know typical models, methods and problems from engineering practice, which can be processed with the kinematics and dynamics of a mass point, together with corresponding solution methods and strategies. The physical way of thinking of mechanics is anchored.

Students achieve the following learning objectives:

Professional Skills

The students have knowledge of the kinematics and dynamics of point masses in one-, two- and three-dimensional space. In addition, they know the concepts of free, forced and damped linear harmonic oscillation. Students are able to work conceptually and methodically. They know the most important physical models and correlations and have applied them in practical exercises. In particular, they know the basic assumptions and theories behind the phenomena to be described. They are also able to select suitable mathematical methods on the basis of a problem description and to systematically work out the solution on the basis of these methods. They have the

knowledge to interpret the results in a subject-specific way. In summary, the students can apply their acquired knowledge to engineering tasks in a practice-oriented way.

Methodological Skills

Depending on the problem, students are able to identify and successfully apply appropriate calculation methods from a range of calculation methods. They can use scientific calculators and, if necessary, computer algebra software. The students have the ability to carry out independent research on the basis of more extensive exercises and to develop their existing knowledge independently.

Soft Skills

The students are aware of their responsibility as future engineers. They are in a position to discursively question problems among themselves, to justify the solutions argumentatively and to critically evaluate the results of their calculations.

Applicability in this and other Programs

In regards to this bachelor degree course: C02, C04, C06, C10, C11, C12, C13, C18, C19, C20, C27, C28, C32, C33, C34, C35, C36, C37, C38, C39, C41, C42, C43, C44, C46, C47, C48, C50

In regards to other degree courses: none

Entrance Requirements

Formally: none

In terms of content: none

Learning Content

1. **Crash course mathematics (differential, integral and vector calculus)**
2. **Kinematics of a mass point**
    - 2.1. Basic kinematic variables
    - 2.2. The one-dimensional motion
    - 2.3. Motions in two- and three-dimensional space
    - 2.4. Falling and throwing motions
    - 2.5. Uniform rotation
    - 2.6. Kinematics in polar coordinates
3. **Dynamics of a mass point**

3.1. Mass and force

3.2. Newtonian Axioms

3.3. Forces that are easy to describe

3.4. Work and energy

3.5. Conservative forces and potential

3.6. Impact and impulse

3.7. The problem of mass variation over time

3.8. Shock processes

3.9. Torque and angular momentum of mass points

4. **Oscillations and vibrations**

4.1. free undamped linear harmonic oscillation

4.2. Damped linear harmonic oscillation

4.3. forced linear oscillation

4.4. Non-linear vibration

Teaching Methods

Lectures and seminaristic lessons in alternation, solving tasks during the lecture and independent extended training of the computing competence on the basis of weekly exercise sheets, detailed solutions to the exercise sheets are each given with a time delay of one week and are to be compared with the own solutions, if questions arise these are clarified in the lecture.

The active participation of the students during the lecture and in the processing of the exercise sheets is particularly important through a discursive style. Challenge and encourage is the motto, so that they are catapulted from an initial passive attitude into a mode of activity.

Recommended Literature

F. Kuypers: Physik für Ingenieure, Band 1. Wiley-VCH 2012.

P. Tipler: Physik für Wissenschaftler und Ingenieure. Springer Spektrum 2015.

S. Roth / A. Stahl: Mechanik und Wärmelehre – Experimentalphysik anschaulich erklärt. Springer Spektrum 2016.

W. Pfeiler: Experimentalphysik, Band 1 – Mechanik, Schwingungen, Wellen. De Gruypter Verlag 2016.

ET-04 PHYSICS 2

Module code	ET-04
Module coordination	Prof. Dr. Johann Plankl
Course number and name	ET 2102 Physics 2
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	5
ECTS	5
Workload	Time of attendance: 75 hours self-study: 75 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	German

Module Objective

Students deal with methods of classical physics. They learn the necessary steps to work out independent solutions for corresponding problems in the field of engineering, whereby they are especially enabled to critically question the selection of the corresponding methods and calculation procedures. The module also includes a practical course in physics in which the students learn how to carry out and evaluate experiments.

In the module Physics 2 students get to know typical models, methods and problems, as well as experiments from engineering practice, which can be processed within the framework of classical physics, together with corresponding solution methods and strategies. The physical way of thinking of classical physics is anchored.

Students achieve the following learning objectives:

Professional Skills

The students have knowledge of coupled oscillations and waves (including acoustics), the mechanics of the rigid body, classical thermodynamics, and electromagnetism. In addition, they can carry out and evaluate physical experiments in a professional manner. The students are able to work conceptually and methodically. They know the most important physical models and correlations and have applied them in practical exercises. In particular, they know the basic assumptions and theories behind the

phenomena to be described. They are also able to select suitable mathematical methods on the basis of a problem description and to systematically work out the solution on the basis of these methods. They have the knowledge to interpret the results in a subject-specific way. In summary, the students can apply their acquired knowledge to engineering problems in a practice-oriented way.

Methodological Skills

Depending on the problem, students are able to identify and successfully apply appropriate calculation methods from a range of calculation methods. They can use scientific calculators and, if necessary, computer algebra software. The students have the ability to carry out independent research on the basis of more extensive exercises and to further develop their existing knowledge independently. In addition, they are familiar with the interplay of theory and experiment, as well as with the procedure for carrying out and evaluating physical experiments.

Soft Skills

The students are aware of their responsibility as future engineers. They are able to discursively question problems among themselves, to argue for solutions and to critically evaluate the results of their calculations and experiments.

Applicability in this and other Programs

In regards to this bachelor degree course: C11, C12, C18, C19, C20, C28, C34, C35, C36, C37, C38, C39, C41, C42, C43, C46, C48, C50

In regards to other degree courses: none

Entrance Requirements

Formally: none

In terms of content: C01, C03, C05

Learning Content

1. **Coupled oscillations and waves**
    - 1.1. Perpendicular superpositon of oscillations: Lissajus figures
    - 1.2. Parallel superposition of oscillations
    - 1.3. The eigenvalue problem with coupled oscillators
    - 1.4. Waves
    - 1.5. Acoustics
2. **The rigid body**

2.1. Model of the rigid body

2.2. Center of mass

2.3. Motion of a free rigid body

2.4. Pairs of force

2.5. Moment of inertia

2.6. Motion around a fixed axis

3. **Thermodynamics**

3.1. Concept of heat

3.2. Temperature and model of the ideal gas

3.3. Thermal expansion of bodies

3.4. The laws of thermodynamics

3.5. Heat transport processes

3.6. Changes of state of ideal gases

3.7. Circular processes

3.8. Kinetic gas theory

3.9. Real gases and phase transformations

4. **Students lab work: physical experiments**

4.1. Introduction to experimental training and error calculation

4.2. Dielectric constant

4.3. Induction law for sinusoidal alternating currents

4.4. Hysteresis

4.5. Helmholtz coil pair

4.6. Hall Effect

4.7. Solar collector and heat pump

4.8. Natural radioactivity

4.9. Double pendulum

4.10. Gyroscope

Teaching Methods

Lecture and seminaristic lessons in alternation, plus a one-hour laboratory course, which is carried out every two hours for 14 days; solving problems during the lecture and independent extended training of the arithmetic competence on the basis of weekly exercise sheets, detailed solutions to the exercise sheets are issued with a time delay of one week each and are to be compared with one's own solutions, if questions arise these are clarified in the lecture. The execution and later evaluation of an experiment usually takes place in teams of two, the return and discussion of the evaluation also takes place with a time delay.

Recommended Literature

F. Kuypers: Physik für Ingenieure, Band 1 und 2. Wiley-VCH 2012.

P. Tipler: Physik für Wissenschaftler und Ingenieure. Springer Spektrum 2015.

S. Roth / A. Stahl: Mechanik und Wärmelehre – Experimentalphysik anschaulich erklärt. Springer Spektrum 2016.

S. Roth / A. Stahl: Elektrizität und Magnetismus – Experimentalphysik anschaulich erklärt. Springer Spektrum 2018.

W. Pfeiler: Experimentalphysik, Band 2 – Wärme, Nichtlinearität, Relativität. De Gruypter Verlag 2016.

W. Pfeiler: Experimentalphysik, Band 3 – Elektrizität und Magnetismus, De Gruypter Verlag 2016.

ET-05 PRINCIPLES OF ELECTRICAL ENGINEERING 1

Module code	ET-05
Module coordination	Prof. Dr. Günter Keller
Course number and name	ET 1103 Principles of Electrical Engineering 1
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	8
ECTS	9
Workload	Time of attendance: 120 hours self-study: 150 hours Total: 270 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	8/210
Language of Instruction	German

Module Objective

The course deals with the fundamentals of studying electrical engineering and information technology, in particular with the basic terms, network analysis and complex AC calculation. The students learn the independent analysis of DC and AC networks.

The students achieve the following learning objectives:

Professional Skills

The students work with the basic concepts and know the necessary units. They analyze both simple and complicated networks with universal procedures. The application of network theorems completes the analysis competence.

Students learn the application of complex AC calculation and can analyze AC networks, which include multiphase systems.

Furthermore, the students learn how to handle transfer functions, their mathematical description and their frequency response.

Methodological skills

The subject is strongly mathematically oriented. For this purpose, the students will get an introduction to their mathematical procedures and their application in theory and examples. The methods are each subdivided and presented in a series of process steps.

Soft Skills

Personal competence lies in the detailed application of mathematical and technical procedures.

Applicability in this and other Programs

In regards to this bachelor degree course: C02, C04, C06, C10, C11, C12, C13, C15, C16, C17, C18, C19, C20, C27, C28, C31, C32, C33, C34, C35, C36, C37, C38, C39, C40, C41, C42, C43, C44, C45, C46, C47, C48, C50

In regards to other degree courses: none

Entrance Requirements

Fornally: none

In terms of content: none

Learning Content

1. **Basic terms**
    - 1.1. Charge, current, voltage
    - 1.2. Power, energy, efficiency
    - 1.3. Sources
    - 1.4. Ohm's Law
2. **Electrical circuits**
    - 2.1. Kirchhoff's laws
    - 2.2. Series and parallel connection
    - 2.3. Mesh Current Analysis, Nodal Potential Analysis
    - 2.4. Network Theorems
    - 2.5. Nonlinear Networks
3. **AC networks**
    - 3.1. Characteristics of AC signals

3.2. Linear network elements

3.3. Complex AC calculation

3.4. Multiphase systems

3.5. Transfer functions

3.6. Frequency response analysis

Teaching Methods

Lecture, weekly supervised exercises with the possibility to reflect your own knowledge and to ask questions. The lecture introduces software tools such as LTspice and Python, which can support self-study very well.

Recommended Literature

Schüßler: Netzwerke, Signale und Systeme I. Springer Verlag 1991.

Weißgerber: Elektrotechnik für Ingenieure I, 11. Auflage. Springer/Vieweg, Wiesbaden 2018.

Weißgerber: Elektrotechnik für Ingenieure II, 10. Auflage. Springer/Vieweg, Wiesbaden 2018.

Weißgerber: Elektrotechnik für Ingenieure Klausurrechnen, 7. Auflage. Springer/Vieweg, Wiesbaden 2018.

M. und N. Marinescu: Elektrotechnik für Studium und Praxis: Gleich-, Wechsel- und Drehstrom, Schalt- und nichtsinusförmige Vorgänge. Springer/Vieweg 2016.

ET-06 PRINCIPLES OF ELECTRICAL ENGINEERING 2

Module code	ET-06
Module coordination	Prof. Dr. Günter Keller
Course number and name	ET 2103 Principles of Electrical Engineering 2
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	7
ECTS	8
Workload	Time of attendance: 105 hours self-study: 135 hours Total: 240 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	8/210
Language of Instruction	German

Module Objective

The course deals with the basics of study of electrical engineering and information technology, in particular with electric filters, transformers, transients, quadripoles and state space representation.

The students learn the autonomous application of the networks as electrical filters, transients quadrupoles and state space representation.

The students achieve the following learning objectives:

Professional Skills

Students apply the fundamentals of electrical engineering I to electrical filters and transformers. They analyze both simple and complex networks in terms of transient phenomena and determine their system responses.

As an important special case of electrical networks, they become acquainted with the description of electrical quadrupoles and carry out calculations with these quadripoles.

Furthermore, the students learn the description of electrical networks using state space representation in mathematical and graphical form.

Methodological skills

The subject is strongly mathematically oriented. For this purpose, the students will get an introduction to their mathematical procedures and their application in theory and examples. The methods are each subdivided and presented in a series of process steps.

Soft Skills

Personal competence lies in the detailed application of mathematical and technical procedures.

Applicability in this and other Programs

In regards to this bachelor degree course: C11, C12, C13, C15, C17, C18, C19, C20, C27, C31, C33, C34, C36, C37, C38, C39, C40, C41, C42, C43, C45, C46, C47

In regards to other degree courses: none

Entrance Requirements

Formally: none

In terms of content: C01, C03, C05

Learning Content

1. **Electric filters**
    - 1.1. Theoretical Basics
    - 1.2. Transformations
    - 1.3. Passive realization
    - 1.4. Active realization
2. **Transformer**
    - 2.1. Structure and functionality
    - 2.2. Measurement on transformers
    - 2.3. Loaded transformers
3. **Transients**
    - 3.1. Linear differential equations
    - 3.2. Laplace transformation

3.3. Application of the Laplace Transform

3.4. Impulse response, step response

3.5. Initial states

4. **State space representation**

4.1. Establishing the state equations

4.2. Structures of State Space Representation

4.3. Solution of state space representation

4.4. Applications

5. **Four-pole theory**

5.1. Four-pole equations

5.2. Four-pole circuits

5.3. Operating parameters

6. **Laboratory experiments: DC and AC networks**

Teaching Methods

Lecture, weekly supervised exercises with the possibility to reflect your own knowledge and to ask questions. The lecture introduces software tools such as LTspice and Python, which can support self-study very well.

Recommended Literature

Büttner: Grundlagen der Elektrotechnik II, 2. Auflage. Oldenbourg, München 2009.

Schüßler: Netzwerke, Signale und Systeme I. Springer Verlag 1991.

Weißgerber: Elektrotechnik für Ingenieure II, 10. Auflage. Springer/Vieweg, Wiesbaden 2018.

Weißgerber: Elektrotechnik für Ingenieure III, 9. Auflage. Springer/Vieweg, Wiesbaden 2015.

Weißgerber: Elektrotechnik für Ingenieure Klausurrechnen, 7. Auflage. Springer/Vieweg, Wiesbaden 2018.

U. Weber: Laplace-Transformation für Ingenieure der Elektrotechnik, 9. Auflage. Vieweg/Teubner, Wiesbaden 2012.

M. Marinescu / N. Marinescu: Elektrotechnik für Studium und Praxis: Gleich-, Wechsel- und Drehstrom, Schalt- und nichtsinusförmige Vorgänge. Springer/Vieweg 2016.

ET-07 PRINCIPLES OF COMPUTER ENGINEERING

Module code	ET-07
Module coordination	Prof. Dr. Andreas Grzemba
Course number and name	ET 1104 Computer Science I ET 1105 Principles of Digital Technology
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	5
ECTS	6
Workload	Time of attendance: 75 hours self-study: 105 hours Total: 180 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	6/210
Language of Instruction	German

Module Objective

Primary learning objective: The students should be able to apply mathematical terms and methods of Boolean algebra to technical tasks in study and work.

To do this, students acquire the following skills:

1. Knowledge of the basics of digital circuits
2. Ability to synthesize and analyze digital systems.
3. Ability to program embedded systems with different programming languages (assembler, C)
4. Knowledge of the basics of digital circuits
5. Ability to synthesize and analyze digital systems
6. Understanding the basics of digital circuits
7. Develop ability to synthesize and analyze digital systems
8. Get to know and apply laws and theorems of Boolean algebra

9. Learning to solve problems of Boolean algebra

Applicability in this and other Programs

For this degree program: C08, C13, C16, C17, C27, C34, C35, C37, C44, C50

For other degree programs: none

Entrance Requirements

See submodul description

Learning Content

See submodul description

Teaching Methods

Seminar-like instruction. In class, the content is developed with the involvement of the students, documented with the help of a gap script, illustrated by examples and flanked and practiced by comprehension questions and 5-minute tasks. Exercises, control questions, suggestions and sample solutions serve the student for reworking and appropriation of the contents. Application-oriented examples and tasks demonstrate the usefulness of the mathematical concepts and methods of Boolean algebra.

Recommended Literature

See submodul description

ET 1104 COMPUTER SCIENCE I

Objectives

The students should be able to substantiate theoretical and practical contents of the lecture within tasks.

The subject is divided into two parts:

1. Basics of Number Systems

Knowledge of the basics of number representations (decimal, dual, hexadecimal, floating-point numbers), as well as knowledge in the calculation of these number systems.

Ability to convert numbers into different number systems.

2. Programming in C

This includes the partitioning of a task into informal algorithms, the implementation into a realization, as well as testing and troubleshooting in the implementation.

In detail, the objectives are:

1. Ability to program tasks with the C programming language
2. Ability to analyze tasks for implementation in C
3. Ability to test and troubleshoot implementations

Learning Content

Basics

1 Number systems

1.1 Definition
1.2 Basis
1.3 Conversion between number systems
1.4 Range of values
1.5 Number table from 0 to 16
1.6 Tasks

2 Computing in the dual system

2.1 Addition
2.2 Subtraction
2.3 Multiplication
2.4 Division
2.5 Decimal places
2.6 Tasks

3 Computing in the hexadecimal system

3.1 Convert
3.2 Number circle
3.3 Addition and subtraction
3.4 Multiplication and Division
3.5 Tasks

4 Negative numbers

4.1 Sign and Amount
4.2 Complement Representation

13.2 Power functions, pow ()
13.3 Random function, rand ()

14 Pointers

14.1 Pointer to variables
14.2 Pointer arithmetic
14.3 Pointer to void
14.4 Pointers to functions

15 Memory, dynamic memory management16 Preprocessor instructions

16.1 Include text, #include
16.2 #define
16.3 Macros
16.4 Conditional compilation

17 Command processor

17.1 Arguments of the command line
17.2 System commands

18 Recursion

19 Structures, further data types

19.1 Struct
19.2 Typedef
19.3 Access to structured data types
19.4 Bit fields
19.5 Union type (union)
19.6 Fields of structure variables

20 Files

21 ASCII table

Entrance Requirements

Formally: none

Type of Examination

part of module exam

Methods

Seminar-like instruction.

After presenting the contents of the lectures and presenting the theoretical background, suitable model tasks are worked through step by step.

In the part number systems, the solution of tasks with paper and pencil without a calculator is particularly emphasized, as this creates a feeling for the numbers. This is urgently needed in the later programming part.

The process of learning programming techniques is done by reworking a lot of illustrative material practically on the computing system, which develops a good autonomy in the course of the semester. The development of the ability to work independently is achieved by various projects, which can then be solved almost independently with the support of the lecturer

The media forms are blackboard, script, exercises collection, beamer, personal computer, overhead projectors and secondary literature.

Recommended Literature

H. Erlenkötter: C Programmieren von Anfang an. Rowohlt Taschenbuch 1999.

ET 1105 PRINCIPLES OF DIGITAL TECHNOLOGY

Objectives

Advanced knowledge of characteristics and application of electric devices.

Functional comprehension and ability to basic comprehension and to practice-oriented assignment of electrical devices.

Developing the ability to synthesize and analyze digital systems.

Get to know and apply laws and theorems of Boolean algebra.

Learning to solve problems of Boolean algebra.

Learning Content

Theorems and laws of switching algebra

1. Switching function
    1.1. Normal forms of switching functions (SF)
    1.2. Minimization of switching functions
2. Combinatorial circuits, switching networks

2.1. General design guidelines

2.2. Code converter

2.3. Comparators

2.4. Multiplexer and demultiplexer

2.5. Algebraic adder

2.6. Dynamic behavior of cominatory circuits

Entrance Requirements

Formally: none

Type of Examination

part of module exam

Methods

Overhead projector, whiteboard, beamer

Recommended Literature

D. Hoffmann: Grundlagen der Technischen Informatik. Hanser Verlag 2009.

G. Scarbata: Synthese und Analyse Digitaler Schaltungen. Oldenburg Verlag 1996.

K. Fricke: Digitaltechnik: Lehr- und Übungsbuch für Elektrotechniker und Informatiker, 7. Auflage. Springer Verlag 2014.

ET-08 COMPUTER SCIENCE

Module code	ET-08
Module coordination	Prof. Dr. Andreas Penningsfeld
Course number and name	ET 2104 Computer Science 2 ET 3101 Computer Science 3
Semester	2, 3
Duration of the module	2 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	6
ECTS	7
Workload	Time of attendance: 90 hours self-study: 120 hours Total: 210 hours
Weight	7/210
Language of Instruction	German

Module Objective

Ability to program embedded systems with various programming languages (assembler, C).

Acquisition of knowledge and skills to use an object-oriented programming language, especially in C ++.

Applicability in this and other Programs

For this degree program: C16, C34, C35, C37

For any other degree program: none

For degree program Informatic III: C 3110

Entrance Requirements

See submodul description

Learning Content

See submodul description

Teaching Methods

See submodul description

Recommended Literature

See submodul description

ET 2104 COMPUTER SCIENCE 2

Objectives

The students should be able to substantiate the theoretical and practical contents of the lecture within complex tasks.

This includes the decomposition of a task into informal algorithms, the implementation in a machine-oriented realization, as well as testing and troubleshooting in the implementation.

In detail, the objectives are:

1. Ability to program tasks with the object-oriented programming language C ++
2. Ability to analyze tasks for implementation in the Programming language C ++
3. Ability to implement databases in the Programming language C ++
4. Ability to test and troubleshoot complex systems

Learning Content

1 Limitation to the programming language C

2 Input / Output

2.1 Comments
2.2 Main program, main ()
2.3 Precompiler statements
2.4 Namespaces, namespace:
2.5 Cin, Cout

3 Classes and Objects

3.1 Object Instances
3.2 Elementary objects int, float, char
3.3 Objects of class string
3.4 Create new classes
3.5 Copying objects
3.6 Static properties of a class
3.7 Static methods of a class

3.8 Inheritance, derived classes:
3.9 Polymorphism, virtual functions
3.10 Overloading operators
3.11 Templates
3.12 Fields

4 Block monitoring

5 References

5.1 Subroutine calls

6 Friendly classes,'friend'

7 Run Time Type Information, RTTI

8 Type conversions 'Type cast'

8.1 Implicit and Explicit Type Conversions
8.2 'Typecasts' in C ++

9 Files

10 Linked lists

Entrance Requirements

Formally: none

In terms of content: C01, C05, C07

Type of Examination

part of module exam, written ex. 90 min.

Methods

The teaching method is seminaristic instruction.

After presenting the contents of the lectures and presenting the theoretical background, suitable model tasks are worked through step by step.

The process of learning programming techniques is done by reworking a lot of illustrative material practically on the computing system, which develops a good autonomy in the course of the semester. The development of the ability to work independently is achieved by various projects, which can then be solved almost independently with the support of the lecturer. An example is the creation of a telephone book on the basis of a self-programmed database.

The media forms are blackboard, script, exercises collection, beamer, personal computer, overhead projectors and secondary literature.

Recommended Literature

H. Erlenkötter: C Programmieren von Anfang an. Rowohlt Taschenbuch 1999.

H. Erlenkötter: C++ Objektorientiertes Programmieren von Anfang an. Rowohlt Taschenbuch 2000.

ET 3101 COMPUTER SCIENCE 3

Objectives

Professional Skills:

Students can independently develop larger object-oriented programs using typical elements of object-oriented programming such as classes, inheritance, and dynamic binding.

Students can work with ready-made classes from libraries.

The students master the programming language C # and know their differences to C ++

Learning Content

Programming language C #

1. Static functions
2. Data types, control structures and operators
3. Classes, attributes, methods
4. Inheritance and Dynamic Binding
5. Vectors
6. Strings
7. Template classes
8. Class libraries

Entrance Requirements

Formally: none

In terms of content: C1107, C2109, C3110

Type of Examination

part of module exam, written ex. 90 min.

Recommended Literature

A. Kühnel: C# 6 mit Visual Studio 2015. Rheinwerk Computing 2015.

L. Czarnecki: C# für Ingenieure. De Gruyter, Oldenbourg 2003.

ET-09 DIGITAL TECHNOLOGY

Module code	ET-09
Module coordination	Prof. Dr. Andreas Grzemba
Course number and name	ET 3102 Digital Technology II
Semester	3
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	4/210
Language of Instruction	German

Module Objective

Primary learning objective: Students should be able to apply sequential circuits and automata to technical tasks in their studies and career.

To do this, students acquire the following skills: knowledge of the basics of sequential circuits and automata; Ability to synthesize and analyze sequential systems.

Applicability in this and other Programs

For this degree program: C35, C44

For any other degree program: none

Entrance Requirements

At least 42 ECTS credits

passed examinations of at least two of the modules Mathematics I (C-01), Physics I (C-03) and Fundamentals of Electrical Engineering I (C-05)

Learning Content

Flip-flop (FF), bistable trigger

1. Basic RS flip-flop
2. D flip-flop
3. JK flip-flop
4. Conversion of flip-flop

Counter

1. Design of synchronous counters
2. Register circuits

Sequential circuits, rear derailleurs, digital vending machines

1. Description and design of derailleurs
2. Rear derailleur of the money changer
3. Operating modes of machines
4. Machine types
5. Completeness and consistency
6. Equivalence of Moore and Mealy machines
7. State reduction
8. Coding of machines
9. Design of complex circuits based on Moore and Mealy automata

Electronic realization of logical functions

1. CMOS logic families

Programmable logic circuits

1. Basic structure
2. PLD, FPGA

Teaching Methods

Seminar-like lectures and internship.

In class, the content is developed with the involvement of the students, documented with the help of a gap script, illustrated by examples and flanked and practiced by comprehension questions and 5-minute tasks. Exercises, control questions, tips and sample solutions serve the student for reworking and appropriation of the contents.

Through application-oriented examples and tasks, the usefulness of terms and methods for the synthesis and analysis of sequential systems becomes clear.

In the internship, the workshops learned in the lecture will be consolidated in 5 workshops. The workshops cover the following topics: Boolean Algebra, Combinatorial Logic and Multiplexer, Sequential Circuits and Counters, Automata, FPGA Programming

Recommended Literature

D. Hoffmann: Grundlagen der Technischen Informatik. Hanser Verlag 2009.

G. Scarbata: Synthese und Analyse Digitaler Schaltungen. Oldenburg Verlag 1996.

K. Fricke: Digitaltechnik: Lehr- und Übungsbuch für Elektrotechniker und Informatiker, 7. Auflage. Springer Verlag 2014.

ET-10 MATERIAL ENGINEERING AND APPLIED SOLID-STATE PHYSICS

Module code	ET-10
Module coordination	Prof. Dr. Günther Benstetter
Course number and name	ET 2105 Material Engineering and Applied Solid-State Physics
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	German

Module Objective

Students learn the basic concepts of solid state construction, their properties as well as the manufacture, assessment and application of materials in electrical engineering.

The students achieve the following learning objectives:

Professional Skills

Knowledge:

1. Basic understanding of structure and physical properties of solids
2. Knowledge of manufacturing and test methods for materials of electrical engineering
3. Knowledge of the application of materials in electrical engineering

Competencies:

1. Ability to methodically assess basic properties and property changes of material systems

2. Ability to select materials according to given specification

Methodological Skills

Transfer of the acquired skills for the assessment and selection of materials to tasks and problems outside of electrical engineering.

Soft Skills

Students will be able to work out solutions to understanding, assessing and using materials both individually and within working groups.

Applicability in this and other Programs

For this degree program: C11, C15, C28, C31, C36, C40, C45, C46, C48, C50

For any other degree program: none

Entrance Requirements

Formally: none

In terms of content: C01, C03, C05

Learning Content

1. Fundamentals of materials
2. Structure of the atoms and the periodic table of the elements
3. Bonding modes in the solid state
4. Amorphous and crystalline solids
5. Structures of chrystals
6. Orientation in the crystal lattice
7. Crystallization
8. Defects in crystalls
9. Diffusion
10. Phases, alloys and state diagrams
11. Characteristic properties of solids
12. Mechanical inspection methods and properties

13. Electrical Properties
14. Optical properties of materials
15. Thermal properties of materials
16. Magnetism
17. Materials of electrical engineering
18. Conductor materials
19. Resistant materials
20. Contact materials
21. Metallic materials in metrology
22. Semiconductor materials
23. Superconductors
24. Dielectric materials
25. Magnetic materials
26. Current trends and developments

Teaching Methods

Seminar-like instruction

Whiteboard, Beamer, Visializer

Recommended Literature

W. Callister / D. Rethwisch: Materialwissenschaften und Werkstofftechnik. Wiley 2012.

J. Shackelford: Werkstofftechnologie für Ingenieure. Pearson Studium 2007.

D. Spickermann: Werkstoffe der Elektrotechnik und der Elektronik. Schlembach Verlag 2002.

L. Van Vlack: Elements of Materials Science and Engineering, Addison Wesley Publishing 1989.

D. Askeland: Materialwissenschaften: Grundlagen, Übungen, Lösungen. Spektrum Akademischer Verlag 1996.

ET-11 ELECTRONIC DEVICES

Module code	ET-11
Module coordination	Prof. Dr. Günther Benstetter
Course number and name	ET 3103 Electronic Devices
Semester	3
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	6
ECTS	6
Workload	Time of attendance: 90 hours self-study: 90 hours Total: 180 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	7/210
Language of Instruction	German

Entrance Requirements

keine

Recommended Literature

H. Göbel: Einführung in die Halbleiter-Schaltungstechnik, 6. Auflage. Springer Lehrbuch 2019.

H. Göbel / H. Siemund: Übungsaufgaben zur Halbleiter-Schaltungstechnik , 4. Auflage. Springer Lehrbuch 2018.

M. Reisch: Halbleiter-Bauelemente, 2. Auflage. Springer Lehrbuch 2011.

R. Müller: Grundlagen der Halbleiter-Elektronik, 7. Auflage. Springer Verlag, Berlin 1995.

R. Müller: Bauelemente der Halbleiter-Elektronik. Springer Verlag, Berlin 1995.

Streetman / Banerjee: Solid State Electronic Devices, 7. edition. Prentice Hall 2014.

S.M. Sze: Physics of Semiconductor Devices, 3. edition. Wiley 2006.

ET-12 ELECTRICAL MEASUREMENT TECHNIQUES

Module code	ET-12
Module coordination	Prof. Dr. Stefan Zorn
Course number and name	ET 3104 Electrical Measurement Techniques
Semester	3
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	
Semester periods per week (SWS)	8
ECTS	8
Workload	Time of attendance: 120 hours self-study: 120 hours Total: 240 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	10/210
Language of Instruction	German

Entrance Requirements

keine

Recommended Literature

W.-J. Becker / K. Bonfig / K. Höing (Hrsg.): Handbuch elektrische Meßtechnik, 2. Auflage. Hüthig, Heidelberg 2000.

U. Kiencke / R. Eger: Messtechnik- Systemtheorie für Elektrotechniker, 6. Auflage. Springer Verlag, Berlin 2005.

R. Lerch: Elektrische Meßtechnik, 3. Auflage. Springer Verlag, Berlin 2007.

R. Lerch / M. Kaltenbacher et al.: Elektrische Messtechnik – Übungsbuch, 2. Auflage. Springer Verlag, Berlin 2005.

Th. Mühl: Grundlagen der elektrischen Messtechnik, 3. Auflage. Vieweg/Teubner, Wiesbaden 2008.

D. Schoen / W. Pfeiffer: Übungen zur elektrischen Messtechnik. VDE Verlag, Berlin 2001.

E. Schrüfer: Elektrische Meßtechnik, 9. Auflage. Hanser Verlag, München 2007.

H.-R. Tränkler: Taschenbuch der Meßtechnik, 4. Auflage. Oldenbourg Verlag, München, Wien 1996.

U. Tietze / Ch.Schenk: Halbleiter-Schaltungstechnik, 13. Auflage. Springer Verlag, Berlin 2009.

G. Engeln-Müllges / K. Niederdrenk / R. Wodicka: Numerik-Algorithmen, 9. Auflage. Springer Verlag, Berlin 2005.

ET-13 CONTROL TECHNIQUES 1

Module code	ET-13
Module coordination	Prof. Dr. Nikolaus Müller
Course number and name	ET 3105 Control Techniques 1
Semester	3
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	4/210
Language of Instruction	German

Module Objective

fundamental knowledge of system dynamics

solve easy calculations relating control systems engineering

Entrance Requirements

content-related: Mathematics: complex numbers, physics, Laplace transformation

Learning Content

introduction

description of dynamci systems in the Block diagram

characteristics of controls (Analysis)

control design (Synthesis)

structure measures (Cascade control)

process of frequency characteristic

Recommended Literature

J. Lunze: Regelungstechnik I, 11. Auflage. Springer Vieweg 2016.

H. Lutz / W. Wendt: Taschenbuch der Regelungstechnik, 11. Auflage. Verlag Harri Deutsch 2014.

H. Mann / H. Schiffelgen / R. Froriep / K.Webers: Einführung in die Regelungstechnik, 12. Auflage. Hanser Verlag 2019.

M. Reuter / S. Zacher: Regelungstechnik für Ingenieure, 15. Auflage. Springer/Vieweg 2017.

W. Schneider / B. Heinrich: Praktische Regelungstechnik, 4. Auflage. Springer/Vieweg 2017.

G. Schulz / K. Graf : Regelungstechnik I. DeGruyter Studium 2015.

ET-14 ELECTRONIC CIRCUITS 1

Module code	ET-14
Module coordination	Prof. Dr. Werner Bogner
Course number and name	ET 4101 Electronic Circuits 1
Semester	4
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	German

Module Objective

Ability to analyze and recognize analog semiconductors

Ability to design and dimension semiconductor circuits

Entrance Requirements

Formally: none
Content-related: fundamental of electrical engineering

Learning Content

Introduction

- Tasks, applications of analog circuits

- Network, network elements

- Symbols

Basics of analog circuits

- Linear two-ports

- Nonlinear circuits

Diode circuits

- Definition and Characteristics

- Equivalent circuits

- Dimensioning

- Simple diode circuits

Basic transistor circuits - Bipolar / FET

- Definition and characteristics

- Equivalent circuits

- Operating at higher frequencies (upper cutoff frequency)

- Setting the operating point

- Simple transistor stages (basic circuits)

- Special circuits

Multi-stage amplifier circuits

- Coupling of transistor stages

- Operational Amplifiers - OPA

Power Amplifiers

- Power dissipation, thermal resistance, cooling problems

- Quasilinear power stages

Lab:
Diode Circuits
NE555
Transistor amplifier
Power amplifier
Differential amplifier
Switching amplifier

Teaching Methods

Seminar based teaching, exercises, laboratory experiments, visualizer, computer simulations.

Remarks

Admission requirements for the examination: Successful participation in the practical course (tests); support through the e-learning platform; practical presentations from industrial application on a case-by-case basis.

Recommended Literature

Tietze / Schenk / Gamm: Halbleiter-Schaltungstechnik, 16. Auflage. Springer Verlag 2019.

Siegl / Zocher: Schaltungstechnik: Analog und gemischt analog/digital, 6. Auflage. Springer/Vieweg 2018.

Köstner / Möschwitzer: Elektronische Schaltungen. Hanser Verlag 1993.

Goerth: Bauelemente und Grundschaltungen. Teubner Verlag 1999.

Wupper: Elektronische Schaltungen I. Springer Verlag 1996.

Wupper / Niemeyer: Elektronische Schaltungen II. Springer Verlag 1996.

ET-15 MICROCOMPUTER TECHNOLOGY

Module code	ET-15
Module coordination	Prof. Dr. Andreas Penningsfeld
Course number and name	ET 4102 Microcomputer Technology
Semester	4
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written student research project
Weight	4/210
Language of Instruction	German

Entrance Requirements

keine

Recommended Literature

G. Schmitt: Programmierung in Assembler und C - Schaltungen und Anwendungen. Oldenbourg-Verlag.

K. Wüst: Mikroprozessortechnik: Grundlagen, Architekturen, Schaltungstechnik und Betrieb von Mikroprozessoren und Mikrocontrollern. Vieweg/Teubner Verlag.

Prof. Penningsfeld Skript Mikrocomputertechnik.

ET-16 DIGITAL SIGNAL PROCESSING

Module code	ET-16
Module coordination	Prof. Dr. Nikolaus Müller
Course number and name	ET 4103 Digital Signal Processing
Semester	4
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	German

Module Objective

Ability to solve tasks of signal processing using digital systems;

Ability to practice on computer simulations and on systems with embedded digital signal processors (DSPs)

Entrance Requirements

Formally: none;

content-related: Mathematics, complex numbers, linear algebra, integral transformation

Learning Content

Description of analog signals in the time domain and frequency domain

Description of time-discrete signals with the aid of the z-transform

Application environments Matlab and DSP

The discrete Fourier transformation (DFT) function Generators

Digital filters (FIR, IIR)

Recommended Literature

D. von Grünigen: Digitale Signalverarbeitung, 5. Auflage. Fachbuch Verlag Leipzig 2014.

V.K.Ingle / J.G.Proakis: Essentials of Digital Signal Processing using MATLAB, 4. Auflage. Cengage Learning 2016.

F. Puente León / H. Jäkel: Signale und Systeme, 6. Auflage. DeGruyter Studium 2015.

A.V. Oppenheim / R.W.Schafer / J.R.Buck: Zeitdiskrete Signalverarbeitung, 2. Auflage. Pearson Studium 2004.

O. Beucher: Übungsbuch Signale und Systeme, 3. Auflage. Vieweg 2018.

M. Meyer: Signalverarbeitung, 7. Auflage. Vieweg 2014.

M. Werner: Signale und Systeme, 3. Auflage. Vieweg 2008.

S.J. Chapman: Matlab Programming for Engineers, 5. Auflage. Cengage 2015.

ET-17 COMMUNICATIONS ENGINEERING 1

Module code	ET-17
Module coordination	Prof. Dr. Matthias Wuschek
Course number and name	ET 4104 Communications Engineering 1
Semester	4
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	German

Module Objective

Ability to analyze an information transmission

Design of simple redundancy reducing or error-detecting and correcting codes

Analysis of lines of communications technology using the line theory

Perform simple transformations with the Smith chart

Calculation of line attenuation

Selection and specification of suitable antennas for concrete communications engineering tasks

Dimensioning of radio transmission lines using simple airshed models

Entrance Requirements

Formally: none

Content-related: Mathematics, fundamentals of electrical engineering

Learning Content

Fundamentals of information theory, coding (redundancy reduction, error detection and correction), transmission line theory

Characteristics of lossless line

Reflection coefficient

Impedance transformation, the Smith chart, lossy lines

Pulses on lossless lines, elementary idea cable types (two wireline, coaxial)

Fundamentals of antenna technology, the key parameters of antennas

Embodiments of antennas, wave propagation mechanisms

Recommended Literature

J. Göbel: Kommunikationstechnik. Hüthig Verlag.

E. Herter / W. Lörcher: Nachrichtentechnik. Hanser Verlag.

M. Werner: Nachrichtentechnik. Vieweg/Teubner Verlag.

J.G. Prokais: Grundlagen der Kommunikationstechnik. Pearson Verlag.

E. Pehl: Digitale und analoge Nachrichtenübertragung. Hüthig Verlag.

M. Meyer: Kommunikationstechnik. Vieweg/Teubner Verlag.

F. Gustrau: Hochfrequenztechnik.

ET-18 ELECTRODYNAMICS

Module code	ET-18
Module coordination	Prof. Dr. Johann Plankl
Course number and name	ET 4105 Electrodynamics
Semester	4
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	German

Module Objective

The module electrodynamics is a one-semester lecture. In the module the students basically deal with methods of classical electrodynamics. They learn the necessary steps to develop independent solutions for corresponding problems from the engineering field, whereby they are particularly enabled to critically question the selection of the corresponding methods and calculation procedures.

In the subject electrodynamics the students get to know typical models, methods and tasks from engineering practice, which can be worked on in the context of classical electrodynamics, together with corresponding solution procedures and strategies. The field-theoretical way of thinking of electromagnetism as an action-at-a-distance phenomenon is anchored.

Professional Skills

Students have knowledge of electrostatics, magentostatics and electrodynamics in vacuum and matter. In addition, they are familiar with the concepts of electromagnetic oscillations and waves. The students are able to work conceptually and methodically. They know the most important physical models and correlations and have applied them in practical exercises. In particular, they know the basic assumptions and theories behind the phenomena to be described. They are also able to select suitable mathematical methods on the basis of a problem description and to

systematically work out the solution on the basis of these methods. They have the knowledge to interpret the results in a subject-specific way. All in all, the students can apply their acquired knowledge to engineering tasks in a practice-oriented way.

Methodological Skills

Depending on the task, students are able to identify and successfully apply appropriate calculation methods from a range of calculation methods. They can use scientific calculators and, if necessary, computer algebra software. The students have the ability to carry out independent research on the basis of more extensive exercises and to develop their existing knowledge independently. Occasionally, English problem texts are also issued.

Soft Skills

The students are aware of their responsibility as future engineers. They are in a position to discursively question problems among themselves, to justify the solutions argumentatively and to critically evaluate the results of their calculations.

Entrance Requirements

Formally: none;

Content-related: Mathematics for engineers

Learning Content

1. Elements of vector analysis

2. Electromagnetism in vacuum

2.1 Introduction

2.2 Phenomenology of a point charge

2.3 Charge densities and Dirac Delta Function

2.4 Electric current and current densities

2.5 Continuity equation

2.6 Coulomb's law of force in electrostatics

2.7 The electrostatic field

2.8 Ampere force law and magnetic field

2.9 The Law of Biot and Savart

2.10 The Basic Laws of Electrostatics and Magnetostatics

3. electromagnetic fields in matter

3.1 Macroscopic media and matter fields

3.2 Matter in an electrostatic field

3.3 Matter in a static magnetic field

3.4 The electric field at interfaces

3.5 The magnetic field at interfaces

4. the scalar and vector potential

4.1 The electrostatic potential

4.2 The integral definition of the scalar potential

4.3 Displacement work within an electrostatic field

4.4 Potential equations of electrostatics

4.5 Electrostatic field energy

4.6 The electrical dipole

4.7 The vector potential and local gauge transformation

4.8 The field equations in potential representation

4.9 Magnetic multipole expansion

4.10 Magnetic field energy

5. Maxwell's Theory of Classical Electrodynamics

5.1 Preliminary remarks

5.2 Faraday law of induction

5.3 Differential formulation of the Maxwell equations

5.4 The Maxwell equations in matter

5.5 The Maxwell equations in integral form and their physical interpretation

5.6 The Maxwell equations in complex formulation for time-harmonic fields

5.7 Description of electromagnetic waves

6. Electromagnetic waves in vacuum and in matter

6.1 The homogeneous wave equations in vacuum

6.2 Wave propagation of monochromatic plane waves

6.3 The energy density of electromagnetic waves: Poynting's theorem

6.4 Generation of electromagnetic waves: the method of Greens functions

6.5 Radiation of the Hertzian dipole

Teaching Methods

Lectures and seminaristic lessons in alternation, solving problems during the lecture and independent extended training of the computing competence on the basis of weekly exercise sheets, detailed solutions to the exercise sheets are each given with a time delay of one week and are to be compared with the own solutions, if questions arise these are clarified in the lecture.

Remarks

The active participation of the students during the lecture and in the processing of the exercise sheets is particularly important through a discursive style. Challenge and encourage is the motto, so that they are catapulted from an initial passive attitude into a mode of activity.

Recommended Literature

D. J. Griffiths: Elektrodynamik. Pearson Verlag 2018.

B. M. Notaros: Electromagnetics. Prentice Hall 2011.

F. T. Ulaby / U. Ravaioli: Fundamentals of Applied Elektromagnetics. Pearson 2015.

A. Zangwill: Modern Electrodynamics. Cambridge University Press 2013.

ET-19 ELECTROMAGNETIC COMPATIBILITY

Module code	ET-19
Module coordination	Prof. Dr. Günter Keller
Course number and name	ET 4106 Electromagnetic Compatibility
Semester	4
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	4/210
Language of Instruction	German

Module Objective

Ability to identify electromagnetic coupling paths

Ability of the application of european and international standards

Ability of the design emc-compliant design of electrical and electronic devices

Entrance Requirements

keine

Learning Content

Terms: terminology and representations of electromagnetic compliance

Coupling paths: Galvanic, capacitive, magnetic, electromagnetic

Standardization: Standardization bodies, european and international noun for the CE marking

EMC equipment design: Circuit boards, devices, EMC filter, shielding

Recommended Literature

Franz: EMV, 5. Auflage. Springer/Vieweg 2013.

Schwab: Elektromagnetische Verträglichkeit, 6. Auflage. Springer/Verlag, Heidelberg 2011.

Montrose: EMC made simple. Montrose Compliance Services 2014.

Williams: EMC for Product Designers. Newnes 2017.

ET-20 ENGLISH FOR ENGINEERS

Module code	ET-20
Module coordination	Tanja Mertadana
Course number and name	ET 6101 English for Engineers
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	4/210
Language of Instruction	English

Module Objective

Englisch für Ingenieure (B2) aims to equip students with specialized language skills necessary for independent performance in a globalized electrical engineering sector. In doing so, it strives to deepen students' relationship with the English language in relevant technical settings so that they can effectively and efficiently implement the language as a practical communication tool.
To this end, the module targets instruction of the four cardinal language skills (listening, reading, speaking, and writing) across a broad spectrum of core technical topics related to electrical engineering. Students also craft the content of their own learning through needs analyses and frequent immersive and self-directed projects. Central to the module is optimizing fluency and communication skills; so too is cultivating a clear understanding of the finer points of textual meaning and meaning produced in dialogue with others. Through a variety of task-based speaking, listening and writing activities, students enhance their oral and aural production and expand their ability to produce clear, concise and coherent pieces of writing – be they in the form of emails, (technical) reports, or expository paragraphs on technical processes. Particular emphasis will be placed on honing students' public speaking and team skills through work on a team presentation project for each course.
On completion of the module students will have achieved the following learning objectives:
Professional competencies

- Students will have an independent command of specialized technical terminology relevant to the field of electrical engineering. Command here refers to oral and written production as well as aural and reading comprehension.
- They will be in a position to deploy study skills such as close reading and coherent writing at a B2-level and for use in niche tasks for the electrical engineering sector.
- They will have gained substantial knowledge of B2-level language registers – both for formal study contexts and for semi-formal to formal professional contexts.
- They will have gained essential experience in presenting on topics related to technical English. The goal here is to package niche knowledge in the protocols of a clearly structured, effectively delivered piece of public speaking.

Methodological competencies

- Students will have enhanced their abilities to structure the acquisition of specialized terminology and grammatical items and practiced ways to internalize new language that yield optimal learning benefits.
- They will have extended and refined their practical research skills in English by engaging in at least two immersion projects – for example, by being asked to present on a discipline-specific topic in an individual or team presentation.

Social competencies

- Students will have gained valuable experience in training other personal effectiveness skills such as team work, integrity, and reliability.
- They will have reflected on the learning benefits derived from several immersion projects.

Entrance Requirements

The minimum entry-level requirement is a B2-level of English according to the Common European Framework of Reference for Language (CEFR). B2-level approximately equates to a good mark in English exam of the German A-levels (Abitur).

Learning Content

Course content is divided across a set of mandatory topics that the lecturer chooses (60% of content) and non-mandatory topics that students elect to work on (40% of content).
Mandatory topics include, but are not restricted to, the following:
1. Mathematical operations and numbers
2. Measurements and units
3. Geometric aspects

4. Fundamentals of electrical engineering (e.g. circuits, physics, control systems)
5. Materials and their properties
6. Case study on an area related to electrical engineering (e.g. Tesla)
7. Communication skills (e.g. presentations)
8. Grammar items (e.g. passive vs active, tenses, conditionals)

Examples of non-mandatory topics include the following:

1. Renewable energy
2. E-mobility
3. Computing
4. Telecommunications
5. Tools and instruments
6. Signal processing

Teaching Methods

Instruction and learning methods focus on training the four cardinal language skills (speaking, listening, reading, and writing) and on enhancing professional and social competencies. They include group discussions and group projects, individual and team work (e.g. individual and group presentations), real- and role-playing, close reading and listening activities, grammar games, method of
loci, running dictations, translations, peer feedback and review, work with learning stations, and various follow-up viewing and writing activities.
Study assignments will be set on a weekly basis.

Recommended Literature

P. Astley / L. Lansford: Engineering 1, Student's Book. Oxford UP, Oxford 2013.

H. Bauer: English for Technical Purposes. Cornelson, Berlin, 2000.

D. Blockley: Engineering: A Very Short Introduction. Oxford UP, Oxford 2012.

D. Bonamy: Technical English 4. Pearson Education 2011.

D. Bonamy / C. Jacques: Technical English 3. Pearson Longman 2011.

W. Büchel et. al. Englisch-Grundkurs für technische Berufe. Klett Verlag, Stuttgart 2001.

Dictionary of Electrical and Computer Engineering. 6. edition. McGraw-Hill, San Francisco 2003.

P. Dummett: Energy English: For the Gas and Electricity Industries. Marshall Cavendish 2010.

Engine: Englisch für Ingenieure. Darmstadt. Various issues.

M. Foley / D. Hall. MyGrammarLab. Pearson 2012.

E. Glendinning / A. Pohl. Technology 2. Oxford UP, Oxford 2008.

E. and N. Glendinning: Oxford English for Electrical and Mechanical Engineering. Oxford UP, Oxford 2001.

S. Hart: Written English: A Guide for Electrical and Electronic Students and Engineers. CRC Press, Boca Raton 2016.

V. Hollett / J. Sydes: Tech Talk: Intermediate. Oxford UP, Oxford 2010.

M. Ibbotson: Cambridge English for Engineering. Cambridge UP, Cambridge 2008.

M. Ibbotson: Professional English in Use Engineering Technical English for Professionals. Cambridge UP, Cambridge 2009.

Inch: Technical English. Karlsruhe. Various issues.

A. Jayendran: English für Elektroniker: Ein Lehr- und Übungsbuch für das technische Englisch. Vieweg Verlag, Wiesbaden 1996.

L. Lansford / P. Astley: Engineering I. Oxford UP, Oxford 2013.

M. Miodownik: Stuff Matters. Penguin, London 2014.

G. Möllerke: Modern English for Mechanical Engineers. Hanser Verlag, München 2010.

R. Munroe: What If? John Murray, London 2015.

K. Praglowski-Leary: Englisch für technische Berufe. Klett Verlag, Stuttgart 2004.

U. Puderbach / M. Giesa. Technical English - Mechanical Engineering. Haan-Gruiten: Verl. Europa-Lehrmittel Nourney, Vollmer 2012.

C. Rovelli: Seven Brief Lessons on Physics. Penguin, London 2014.

R. Smith: English for Electrical Engineering. Garnet Education 2014.

The Science Book: Big Ideas Simply Explained. DK, London 2014.

W. Schäfer et al: Electricity Milestones: Englisch für Electroberufe. Klett Verlag, Stuttgart 2013.

G. Wagner / M. Loyd Zörner: Technical Grammar and Vocabulary: A Practice Book for Foreign Students. Cornelsen, Berlin 1998.

ET-21 KEY COMPETENCIES

Module code	ET-21
Module coordination	Prof. Dr. Thomas Geiß
Course number and name	ET 7101 Business Administration ET 7102 Scientific Work Practice
Semester	7
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	
Semester periods per week (SWS)	4
ECTS	6
Workload	Time of attendance: 60 hours self-study: 120 hours Total: 180 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	3/210
Language of Instruction	German

Entrance Requirements

keine

Recommended Literature

G. Wöhe: Einführung in die Allgemeine Betriebswirtschaftslehre, 25. Auflage. Vahlen Verlag, München 2013.

P. Mertens / F. Bodendorf: Programmierte Einführung in die Betriebswirtschaftslehre. Gabler Verlag, Wiesbaden 2001.

J. Drukarczyk / S. Lobe: Finanzierung, 11. edition. Stuttgart 2014.

L. Perridon / M. Steiner / A. Rathgeber: Finanzwirtschaft der Unternehmung, 16. edition. München 2012.

G. Wöhe / J. Bilstein / D. Ernst / J. Hächer: Grundzüge der Unternehmensfinanzierung, 10. edition. München 2009.

ET-22 GENERAL ELECTIVE

Module code	ET-22
Module coordination	Tanja Mertadana
Course number and name	ET 2106 General Elective 1 ET 3106 General Scientific Elective 2
Semester	2, 3
Duration of the module	2 semester
Module frequency	annually
Course type	required course
Level	
Semester periods per week (SWS)	4
ECTS	4
Workload	Time of attendance: 60 hours self-study: 60 hours Total: 120 hours
Type of Examination	Prüfung Sprachenzentrum / AWP
Weight	4/210
Language of Instruction	German

Entrance Requirements

keine

ET 2106 GENERAL ELECTIVE 1

Type of Examination

Prüfung Sprachenzentrum / AWP

ET 3106 GENERAL SCIENTIFIC ELECTIVE 2

Type of Examination

Prüfung Sprachenzentrum / AWP

ET-23 BACHELOR THESIS

Module code	ET-23
Module coordination	Prof. Dr. Martin Jogwich
Course number and name	ET 7103 Bachelor Thesis ET 7104 New Module
Semester	7
Duration of the module	1 semester
Module frequency	each semester
Course type	required course
Level	
Semester periods per week (SWS)	2
ECTS	14
Workload	Time of attendance: 30 hours self-study: 390 hours Total: 420 hours
Type of Examination	bachelor thesis
Weight	12/210
Language of Instruction	German

Entrance Requirements

keine

ET-24 INTERNSHIP

Module code	ET-24
Module coordination	Prof. Dr. Detlef Brumbi
Course number and name	ET 5101 Internship ET 5102 Practical Seminar
Semester	5
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Semester periods per week (SWS)	2
ECTS	25
Workload	Time of attendance: 0 hours self-study: 750 hours Total: 750 hours
Type of Examination	internship certification
Language of Instruction	German

Module Objective

Anchoring and expanding the already learned knowledge through practical experience. the importance of teamwork to get to know target group-oriented presentation of the tasks during the plant work and the results achieved in the work.

Anchoring and expanding the already learned knowledge through practical experience. The importance of teamwork to get to know target group-oriented presentation of the tasks during the plant work and the results achieved in the work.

ET 5101 INTERNSHIP

Objectives

Anchoring and expanding the already learned knowledge through practical experience. the importance of teamwork to get to know target group-oriented presentation of the tasks during the plant work and the results achieved in the work.

Learning Content

Individual

Entrance Requirements

Formally: at least 70 ETCS credits;

Content-related: application of the achievement knowledge of the study program

Type of Examination

internship certification

ET 5102 PRACTICAL SEMINAR

Objectives

Anchoring and expanding the already learned knowledge through practical experience. The importance of teamwork to get to know target group-oriented presentation of the tasks during the plant work and the results achieved in the work.

Learning Content

Induvidual

Entrance Requirements

Formally: at least 70 ECTS;

Content-related: application of the achieved knowledge of the study program

Type of Examination

written course asessment, oral course asessment

ET-25 PRACTICAL TRAINING SEMINAR

Module code	ET-25
Module coordination	Prof. Dr. Detlef Brumbi
Course number and name	ET 5103 Practical Training Seminar 1 ET 5104 Practical Training Seminar 2
Semester	5
Duration of the module	1 semester
Module frequency	each semester
Course type	required course
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Language of Instruction	German

Module Objective

Studying contents being directly realted to practical activities as an electrical engineer

Studying contens being directly related to practical activities as an electrical engineer

ET 5103 PRACTICAL TRAINING SEMINAR 1

Objectives

Studying contents being directly realted to practical activities as an electrical engineer

Learning Content

diverse

Entrance Requirements

at least 70 ETCS credits

Type of Examination

ET 5104 PRACTICAL TRAINING SEMINAR 2

Objectives

Studying contens being directly related to practical activities as an electrical engineer

Learning Content

Diverse

Entrance Requirements

at least 70 ECTS credits

Type of Examination

ET-26 CONTROL TECHNIQUES 2

Module code	ET-26
Module coordination	Prof. Dr. Nikolaus Müller
	Automatisierungstechnik (AUT)
Course number and name	ET 6102 Control Techniques 2
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 120 min.
Duration of Examination	120 min.
Weight	6/210
Language of Instruction	German

Module Objective

The aim is for the students to broaden their knowledge in control engineering and to be prepared for typical tasks in the industry.
After completing the subject, the students have achieved the following learning objectives:
They are able to construct root loci and thereby develop control units
Students can explain the special effects of a digital controller
They know the basics of the analysis of control circuits with switching regulators
Students are capable to represent controlled systems in state space
They can model dynamic control paths in Matlab / Simulink and analyze their behavior

Studenent are capable to solve complex problems in the field of control engineering

Entrance Requirements

Formally: at least 70 ECTS credits

In terms of content:

Mathematics: Linear algebra, Laplace

Control engineering: Understanding dynamic systems

Learning Content

1. Root locus
    1.1. Design rules
    1.2. Analysis and synthesis of control circuits
2. Digital control circuits
    2.1. Description in the z-area
    2.2. Quasi-continuous design
3. Switching regulators
    3.1. Analysis for first-order control paths
    3.2. Analysis for second-order control paths
4. Controller in state space
    4.1. Establishment of state equations
    4.2. Draft according to the pole placement method

Teaching Methods

Seminar-like instruction, exercises

Recommended Literature

J. Lunze: Regelungstechnik 1, 10. Auflage. Springer/Vieweg 2014.

H. Lutz / W. Wendt: Taschenbuch der Regelungstechnik, 10. Auflage. Verlag Harri Deutsch 2014.

H. Mann / H. Schiffelgen / R. Froriep / K. Webers: Einführung in die Regelungstechnik, 12. Auflage. Hanser Verlag 2019.

M. Reuter / S. Zacher: Regelungstechnik für Ingenieure, 15. Auflage. Springer Vieweg 2017.

G. Schulz / K. Graf : Regelungstechnik 1, 5. Auflage. DeGruyter Studium 2015.

G. Schulz / K. Graf : Regelungstechnik 2, 3. Auflage. DeGruyter Studium 2013.

R.C. Dorf / R.H. Bishop: Modern Control Systems, 13. Auflage. Pearson 2017.

ET-27 PRINCPLES OF AUTOMATION TECHNOLOGY

Module code	ET-27
Module coordination	Prof. Dr. Martin Jogwich
	Automatisierungstechnik (AUT)
Course number and name	ET 6103 Principles of Automation Technology
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	6/210
Language of Instruction	German

Module Objective

Thorough knowledge of the structures of automation and process control systems, including their representations

Thorough knowledge of all aspects of sensory operation in automation systems (using selected process technology

examples)

Entrance Requirements

Formally: at least 70 ECTS credits;

Content-related: Basic knowledge of metrology and control engineering, basics in mathematics and physics

Learning Content

Usage of sensors in automation systems and their aspects (including security, accuracy, cross-influences, influencing the process, signal transmission)

Automation and process control systems (tasks, structures, representations)

Interaction between sensors, control systems and actuators in automation system (using selected process technology examples)

Recommended Literature

J. Bergmann: Automatisierungs- und Prozessleittechnik. Fachbuchverlag Leipzig.

P. Beater: Grundkurs der Steuerungstechnik. Books On Demand.

N. Becker: Automatisierungstechnik. Vogel Verlag.

Th. Bindel / D. Hofmann: Projektierung von Automatisierungsanlagen. Vieweg/Teubner Verlag.

K. Früh: Handbuch der Prozessautomatisierung. Oldenbourg Verlag.

H.J. Gevatter: Automatisierungstechnik. Springer Verlag.

T. Heimbold: Einführung in die Automatisierungstechnik. Carl Hanser Verlag.

S. Hesse / G. Schnell: Sensoren für die Prozess- und Fabrikautomation.

S. Hesse: Fertigungsautomatisierung. Vieweg/Teubner Verlag.

C. Karaali: Grundlagen der Steuerungstechnik. Springer/Vieweg Verlag.

R. Lauber / P. Göhner: Prozessautomatisierung. Springer Verlag.

L. Litz: Grundlagen der Automatisierungstechnik. Oldenbourg Verlag.

G. Strohrmann: Automatisierungstechnik. Oldenbourg Verlag.

G. Strohrmann: Automatisierungstechnik verfahrenstechnischer Prozesse. Oldenbourg Verlag.

F. Tröster: Steuerungs- und Regelungstechnik für Ingenieure. Oldenbourg Verlag.

H. Winter: Prozessleittechnik in Chemieanlagen. Europa Lehrmittel.

ET-28 SENSOR-ACTUATOR NETWORKS

Module code	ET-28
Module coordination	Prof. Dr. Andreas Grzemba
	Automatisierungstechnik (AUT)
Course number and name	ET 6104 Sensor-Actuator Networks
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	6/210
Language of Instruction	German

Entrance Requirements

keine

Recommended Literature

W. Zimmermann / R. Schmidgall: Bussysteme in der Fahrzeugzechnik, 3. Auflage. Vieweg 2008.

W. Lawrenz / Nils Obermöller: CAN: Controller Area Network: Grundlagen, Design, Anwendungen, Testtechnik. VDE-Verlag.

K. Matheus / T. Königseder: Automotive Ethernet. Cambridge University Press

AVB/TSN IEEE802.3 Standard-Familie

ET-29 FACTORY AUTOMATION (SPS)

Module code	ET-29
Module coordination	Prof. Dr. Terezia Toth
	Automatisierungstechnik (AUT)
Course number and name	ET 6105 Factory Automation (SPS)
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	6/210
Language of Instruction	German

Entrance Requirements

keine

Recommended Literature

R. Laubner / P. Göhner: Prozessautomatisierung 1. Springer Verlag 1999.

G. Wellenreuther / D. Zastrow: Steuerungstechnik mit SPS. Springer/Vieweg 2015.

G. Wellenreuther: Automatisieren mit SPS - Übersichten und Übungsaufgaben. Springer/Vieweg 2015.

K.H. John / M. Tiegelkamp: SPS-Programmierung mit IEC. Springer Verlag 2009.

G. Schnell: Bussysteme in der Automatisierungstechnik, 4.Auflage. Vieweg-Verlag 2000.

W. Kriesel / O. Madelung: AS-Interface – Das Aktuator-Sensor-Interface für die Automation. Hanser Verlag 1999.

M. Popp: Profibus-DP/DPV1. 2. Auflage. Hüthig Verlag 2000.

M. Popp: Das PROFINET IO-Buch: Grundlagen und Tipps für Anwender, 2. Auflage. VDE Verlag 2010.

Ausbildungsunterlagen der Fa. Siemens: https://www.siemens.com/global/de/home/unternehmen/nachhaltigkeit/ausbildung/sce.html

ET-30 POWER ELECTRONICS

Module code	ET-30
Module coordination	Prof. Dr. Otto Kreutzer
	Automatisierungstechnik (AUT)
Course number and name	ET 6106 Power Electronics
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	6/210
Language of Instruction	German

Module Objective

The course covers power electronics, their components, circuits and applications.

In the field of power electronics, students learn the application of the components and circuits of the power electronics and their applications.

The students achieve the following learning objectives:

Professional Skills

The students learn the structure and mode of operation of passive and active components of power electronics. Here, the parasitic properties are in the foreground.

The circuits are subdivided into network-controlled and self-commutated circuits. Here, the students know not only the circuits themselves but also the mode of operation and their design. The self-guided circuits are the focus.

Methodological Skills

The students learn the structural composition of components in circuit technology as

well as in systems engineering. You can apply the component design methodology to a variety of circuits.

Soft Skills

Skills lie in the detailed application of mathematical and technical procedures.

Applicability in this and other Programs

For this degree program: C 32

For any other degree program: none

Entrance Requirements

Formally: at least 80 ECTS Credits, successful completion of internship

In terms of content: C01, C02, C05, C06, C10, C11, C15

Learning Content

1. Components
    - 1.1. Capacitors
    - 1.2. Choke
    - 1.3. Transformers
    - 1.4. Diodes
    - 1.5. MOSFET
    - 1.6. IGBT
    - 1.7. Thyristor
2. Mains-controlled converters
    - 2.1. Overview
    - 2.2. Center tap circuits
    - 2.3. Bridge circuits
    - 2.4. Cyclo converter
3. Self-commutated power converters
    - 3.1. DC chopper basic circuits

3.2. Mehrquadrantenumrichter

3.3. Single-phase pulse converter

3.4. Three-phase pulse converter

3.5. Applications for pulse converters

3.6. Multilevel converters

3.7. Matrix converter

Teaching Methods

Seminar-like instruction

During lecutres the simulations programm LTspice is being used. This software is a helplul tool for independent studies.

Recommended Literature

F. Zach: Leistungselektronik, Band I und Band II, 5. Auflage. Springer/Vieweg 2015.

J. Specovius: Grundkurs Leistungselektronik, 9. Auflage. Springer Vieweg 2018.

D. Schröder / R. Marquardt: Leistungselektronische Schaltungen: Funktion, Auslegung und Anwendung, 4. Auflage. Springer/Vieweg 2019.

ET-31 AUTOMOTIVE ELECTRONICS

Module code	ET-31
Module coordination	Prof. Dr. Nikolaus Müller
	Automatisierungstechnik (AUT)
Course number and name	ET 7105 Automotive Electronics
Semester	7
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	6/210
Language of Instruction	German

Module Objective

Understanding of the specific challenges of the electronics in motor vehicle

Overview of common techniques in various fields of vehicle electronics

Entrance Requirements

Formally: at least 70 ECTS credits;

Content-related: Fundamentals of electrical engineering

Learning Content

History and economic importance

Drive (powertrain) - combustion engines, electric and hybrid drives, sensores, actuators

Chassis systems

Systems in the vehicle body

Electric infrastructure: electrical system, communication

Control devices: hardware and software and its development

Recommended Literature

K. Borgeest: Elektronik in der Fahrzeugtechnik, 3. Auflage. Springer/Vieweg 2014.

K. Reif (Hrsg.): Bosch Autoelektrik / Autoelektronik, 6. Auflage. Springer/Vieweg 2011.

K. Reif: Automobilelektronik, 5. Auflage. Vieweg 2014.

H. Wallentowitz / K. Reif (Hrsg.): Handbuch Kraftfahrzeugelektronik, 2. Auflage. Springer/Vieweg 2011.

W. Zimmermann / R. Schmidgall: Bussysteme in der Fahrzeugtechnik, 5. Auflage. Springer/Vieweg 2014.

J. Schäuffele / Th. Zurawka: Automotive Software Engineering, 6. Auflage. Springer/Vieweg 2016.

VDI-Gesellschaft für Fahrzeug- und Verkehrstechnik (FVT): Elektronik im Kraftfahrzeug, VDI-Berichte. VDI Verlag, 2013.

Robert Bosch GmbH: Kraftfahrtechnisches Taschenbuch, 29. Auflage. Springer/Vieweg 2019.

ET-32 ELECTRIC MACHINES AND DRIVES

Module code	ET-32
Module coordination	Prof. Dr. Peter Firsching
	Automatisierungstechnik (AUT)
Course number and name	ET 7106 Electric Machines and Drives
Semester	7
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	6/210
Language of Instruction	German

Module Objective

To introduce students to electrical machines and power systems

Entrance Requirements

Formally: at least 80 ECTS credits;

Content-related: fundamentals of ET, physics for engineers, etc.

Learning Content

The course content may include the following topics:

DC machines

AC machine windings

Space vector theory

Steady state analysis of AC machines (polyphase and single phase)

Transmission lines

Power system representation

Power flow

Recommended Literature

R. Fischer: Elektrische Maschinen, 16. Auflage. Hanser Verlag 2013.

H. Stölting: Handbuch Elektrische Kleinantriebe, 4. Auflage. Hanser Verlag 2011.

J. Specovius: Grundkurs Leistungselektronik, 4. Auflage. Springer Verlag 2010.

A. Kremser: Elektrische Maschinen und Antriebe. Teubner Verlag 2004.

H. Merz: Elektrische Maschinen und Antriebe. VDE Verlag 2001.

E. Hering / A. Vogt / K. Bressler: Handbuch der elektrischen Anlagen und Maschinen. Springer Verlag 1999.

U. Riefenstahl: Elektrische Antriebstechnik. Teubner Verlag 2000.

P. Brosch: Moderne Stromrichterantriebe. Vogel Verlag 1998.

H. Linse / R. Fischer: Elektrotechnik für Maschinenbauer, Kapitel 4 und 5. Teubner Verlag 2000.

ET-33 COMMUNICATION TECHNOLOGY / NETWORK ENGINEERING

Module code	ET-33
Module coordination	Prof. Dr. Terezia Toth
	Nachrichtentechnik und Elektronik (NTE)
Course number and name	ET 6107 Communication Technology / Network Engineering
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	German

Entrance Requirements

keine

Recommended Literature

R. Laubner / P. Göhner: Prozessautomatisierung 1. Springer Verlag 1999.

G. Schnell: Bussysteme in der Automatisierungstechnik. 4. Auflage. Vieweg Verlag 2000.

W. Kriesel / O. Madelung: AS-Interface – Das Aktuator-Sensor-Interface für die Automation. Hanser Verlag 1999.

M. Popp: Profibus-DP/DPV1, 2. Auflage. Hüthig Verlag 2000.

M. Popp: Das PROFINET IO-Buch: Grundlagen und Tipps für Anwender, 2.Auflage. VDE Verlag 2010.

W. Zimmermann / R. Schmidgall: Bussysteme in der Fahrzeugtechnik, 5. Auflage. Springer/Vieweg Verlag 2014.

ET-34 RADIO FREQUENCY (RF) ELECTRONICS

Module code	ET-34
Module coordination	Prof. Dr. Werner Bogner
	Nachrichtentechnik und Elektronik (NTE)
Course number and name	ET-6108 High Frequency Electronics
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	German

Module Objective

In the subject RF Electronics, students generally deal with the special features of raio frequency (RF) components and circuits with a focus on RF amplifiers. They will learn the steps needed to deploy RF components on their own and will be able to design, analyze, optimize and evaluate circuits.

The students learn the necessary steps to independently apply RF components and RF cables as well as to develop RF amplifiers. They are able to analyze and evaluate RF circuits. Students gain the ability to design, simulate, and optimize RF semiconductor amplifiers.

The students achieve the following learning objectives:

Professional Skills

The students know the most important modern components of RF technology and understand how it works.

The students understand the peculiarities of high RF circuits, can describe them and are familiar with scattering parameters and their application. They know programs for the simulation of RF circuits and RF structures.

Students are familiar with different transmission line structures for RF applications and can dimension, rate and select them for the application.

Methodological Skills

The students can analyze and apply modern components of RF technology. They can judge the possible uses of these components.

Students have the ability to analyze and apply RF circuits, in particular to adapt and optimize RF amplifiers. They have the ability to design and dimension simple RF circuits.

Soft Skills

The students are able to critically evaluate RF components and circuits.

Entrance Requirements

Formally: at least 80 ETCS credits

In terms of content: telecommunication I, circuit technology I, fundamentals of ET

Learning Content

1. Active components of RF technology
2. Transmission lines (waveguide)
    - 2.1. TEM waveguide
    - 2.2. Basics of Transmission Line Theory
    - 2.3. Waveguide (hollow waveguide)
    - 2.4. Planar microwave lines - stripline
3. Basics of RF circuit development
    - 3.1. Impedance transformation
    - 3.2. Presentation and dimensioning of linear circuits

Teaching Methods

seminar-based teaching with exercises, computer simulations

Recommended Literature

Tietze / Schenk / Gamm: Halbleiter-Schaltungstechnik, 16. Auflage. Springer Verlag 2019.

H. H. Meinke / F. W. Gundlach: Taschenbuch der Hochfrequenztechnik, 5. Auflage. Springer Verlag, Berlin 1992.

W. Bächtold: Mikrowellenelektronik. Vieweg Verlag, Braunschweig 2002.

W. Bächtold: Mikrowellentechnik. Vieweg Verlag, Braunschweig 1999.

B. Huder: Grundlagen der Hochfrequenz-Schaltungstechnik. Oldenbourg Wissenschaftsverlag, Berlin 2018.

E. Voges: Hochfrequenztechnik, 3. Auflage. Hüthig Verlag, Bonn, 2004.

H. Heuermann: Hochfrequenztechnik. 3. Auflage, Springer Verlag, 2018.

Vetter: Schaltungstechnische Praxis. Verlag Technik 2001.

Kurz / Mathis: Oszillatoren. Hüthig-Verlag 1994.

Maas: The RF and Microwave Circuit Handbook. Artech House 1998.

Cripps: RF Power Amplifiers for Wireless Communications, 2nd edition. Artech House 2006.

Pozar: Microwave and RF Design of Wireless Systems. John Wiley & Sons 2001.

ET-35 MAINS-SUPPLIED COMMUNICATION

Module code	ET-35
Module coordination	Prof. Dr. Matthias Wuschek
	Nachrichtentechnik und Elektronik (NTE)
Course number and name	ET 6109 Mains-Supplied Communication
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	6/210
Language of Instruction	German

Module Objective

- Digital modulation of a pulse carrier (PAM, PCM)
- Digital signal transmission in baseband, application examples (ISDN)
- Broadband transmission via subscriber lines (DSL-X)
- Important basic facts of optics, as far as it to understand the opt. transmission technology are important
- Different fiber types: design and function way forward and disadvantages, major application areas
- Design and operation of the main transmission and receiving elements of the opt. telecommunications (LED, LD, PIN photodiode, APD; possibilities of amplification of light signals)
- Significant components of the fiber optic transmission technology (links, couplers, switches, etc.), dimensioning of simple fiber optic networks
- Measuring the opt. telecommunications (power meter, spectrum analyzer, OTDR)

Entrance Requirements

Formally: at least 70 ETCS credits;

In relation to content: telecommunication I, circuit technology I, semiconductor electronics

Learning Content

Sampling theorem, PAM, PCM, ISDN, DSL-X;

Optical foundations; fiber optics; construction of optical transmission systems; transmitting and receiving elements, opt. amp;

Detachable and non-detachable fiber optic connections, and optical coupler switches, planning, measurement

Recommended Literature

A. Keller: Breitbandkabel und Zugangsnetze. Springer Verlag.

V. Brückner: Elemente optischer Netze. Vieweg/Teubner Verlag.

D. Eberlein: Lichtwellenleitertechnik. Expert Verlag.

D. Eberlein: DWDM. Verlag Dr. M. Siebert GmbH.

C. P. Wrobel: Optische Übertragungstechnik in der Praxis. Hüthig Verlag.

B. Bundschuh / J. Himmel: Optische Informationsübertragung. Oldenbourg Verlag.

V. Brückner: Optische Nachrichtentechnik.Teubner Verlag.

D. Gustedt / W. Wiesner: Fiberoptik Übertragungstechnik.Franzis Verlag.

A. Weinert: Plastic Optical Fibers.Wiley Verlag.

H. Kolimbis: Fiber Optic Communications. Pearson Education International Verlag.

ET-36 MOBILE COMMUNICATION

Module code	ET-36
Module coordination	Prof. Dr. Matthias Wuschek
	Nachrichtentechnik und Elektronik (NTE)
Course number and name	ET 6110 Mobile Communication
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	6/210
Language of Instruction	German

Module Objective

- Capability to describe the mobile channel in terms of its essential transmission characteristics

- Implementation of the basic steps for planning cellular networks (coverage, interference, capacity)

- Practical application: GSM/ UTMS/ DVB

Entrance Requirements

Formally: at least 70 ETCS

In relation to content: Fundamentals of ET, mathematics, telecommunication I and II

Learning Content

Historical development;

Key features of the mobile radio channel (path loss, shadowing, multipath, fading);

Design cellular wireless networks, basic knowledge of architecture and operation of a GSM network, in addition some aspects of other networks (UMTS) introduction to digital TV broadcast (DVB)

Recommended Literature

J. Schiller: Mobilkommunikation. Verlag Addison-Wesley.

N. Geng / W. Wiesbeck: Planungsmethoden für die Mobilkommunikation. Springer Verlag.

P. Hatzold: Digitale Kommunikation über Funk. Franzis Verlag.

K. David / T. Benkner: Digitale Mobilfunksysteme. B.G. Teubner Verlag.

S. R. Saunders: Antennas and Propagation for Wireless Communication Systems. Wiley Verlag.

C. Lüders: Mobilfunksysteme. Vogel Fachbuchverlag.

S. Redl / M. Weber: GSM-Technik und Messpraxis. Franzis' Verlag.

C. Lüders: Lokale Funknetze. Vogel Fachbuchverlag.

W. Fischer: Digitale Fernsehtechnik in Theorie und Praxis. Springer Verlag.

ET-37 TELECOMMUNICATION 2

Module code	ET-37
Module coordination	Prof. Dr. Matthias Wuschek
	Nachrichtentechnik und Elektronik (NTE)
Course number and name	ET 6111 Mobile Communication
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	6/210
Language of Instruction	German

Module Objective

The students first deal with the disturbed transmission channel. They will learn important description variables for distortion, crosstalk and noise. In the next step, important analogue modulation methods will be introduced, whereby their description variables and signal form as well as examples of modulators and demodulators will be presented and explained. Then important methods of digital modulation of a sine-wave carrier (ASK, FSK, MSK, M-PSK, M-QAM) are presented and compared with each other. For all important analog and digital modulation methods, the students get to know essential practical fields of application. After a presentation of the spread spectrum transmission an introduction into the transmitter and receiver technology takes place.

The students achieve the following learning objectives:

Professional Skills

The students know and understand important fault phenomena occurring during signal transmission as well as their description variables.

The students know and understand important methods of analog or digital modulation of a sine-wave carrier and can compare these with regard to their performance.

The students know and understand elementary methods for spread spectrum signal transmission

The students know and understand the functionality of the various modules in the transmitter and receiver. They know the advantages and disadvantages of a heterodyne receiver compared to the straight receiver.

Methodological Skills

The students are able to dimension simple analog or modulated transmission links (in particular with regard to bandwidth requirements and interference immunity).

The students can explain the functionality of elementary circuits for the generation of modulated signals or for demodulation.

The students have the ability to independently research and develop existing basic knowledge.

Soft Skills

The students are able to explain the basic procedures of the analogue and digital modulation methods, to justify them reasonably and to critically evaluate them.

Entrance Requirements

Formally: at least 70 ETCS credits;

In terms of content: fundamentals of ET, mathematics

Learning Content

1. Introduction to the lecture
2. The faulty transmission channel
    - 2.1. Introduction
    - 2.2. Calculating with logarithmic quantities
    - 2.3. Linear and nonlinear distortions
    - 2.4. Crosstalk
    - 2.5. Noise
3. Introduction to the modulated signal transmission
    - 3.1. Advantages of modulated signal transmission

3.2. Overview of common modulation methods

3.3. Linear and non-linear modulation methods

3.4. Abbreviations

4. Analog modulation methods

4.1. The sine-wave carrier and his description

4.2. Amplitude modulation

4.3. Frequency modulation

4.4. Quadrature Amplitude modulation

4.5. Applications

5. Digital modulation methods

5.1. Basic methods

5.2. Basics

5.3. Amplitude shift keying ASK

5.4. Phase shift keying PSK

5.5. Frequency shift keying FSK

5.6. Minimum Shift Keying MSK

5.7. Hybrid modulation methods (QAM)

5.8. Synchronization method

5.9. Spread Spectrum methods

Teaching Methods

Seminar-like instruction, exercises

Remarks

Lesson support through the onnline learnmanagementsystem iLearn

Recommended Literature

J. Göbel: Kommunikationstechnik. Hüthig Verlag.

E. Herter / W. Lörche: Nachrichtentechnik. Hanser Verlag.

M. Werner: Nachrichtentechnik. Vieweg Verlag.

E. Pehl: Digitale und analoge Nachrichtenübertragung. Hüthig Verlag.

M. Meyer: Kommunikationstechnik. Vieweg Verlag.

R. Mäusl / J. Göbel: Analoge und digitale Modulationsverfahren. Hüthig Verlag.

H. Weidenfeller / A. Vlcek: Digitale Modulationsverfahren mit Sinusträger. Springer Verlag.

ET-38 RF - MEASUREMENT / MICROWAVE CIRCUIT DESIGN

Module code	ET-38
Module coordination	Prof. Dr. Matthias Wuschek
	Nachrichtentechnik und Elektronik (NTE)
Course number and name	ET 7107 RF - Measurement / Microwave Circuit Design
Semester	7
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written student research project
Weight	6/210
Language of Instruction	German

Module Objective

- The student knows the basic principles of measurement and equipment of RF and Communications Engineering

- He can specify which sizes are determined by the respective devices and he knows the Opportunities of boundaries of different measurement methods

- The practicalities of the instruments within the laboratory experiments are practiced intensively

- Deep knowledge of the application of high-frequency circuits in the communication technology and its metrological characterization

- Ability to simulate high-frequency circuits of the communication equipment to size and design with commercial microwave
CAD software

Entrance Requirements

keine

Learning Content

Laboratory experiments:

- amplitude modulation
- frequency modulation
- Dig. Modulation method u.GSM mobile
- UMTS
- DVBT
- LNA
- scattering parameters
- oscillator
- mixer

Recommended Literature

Käs / Pauli: Mikrowellentechnik. Franzis Verlag.

B. Schiek: Grundlagen der Hochfrequenzmesstechnik. Springer Verlag.

Thumm / Wiesbeck: Hochfrequenzmesstechnik. Springer Verlag.

Hofmann: Nachrichtenmesstechnik. Verlag Technik Berlin.

Rauscher: Grundlagen der Spektralanalyse. Rohde & Schwarz.

Sutter / Gerstner: EMV-Messtechnik. Franzis Verlag.

Göpel / Genz: EMV-Messplätze. Franzis-Verlag.

Redl / Weber: GSM-Technik und Messpraxis. Franzis Verlag.

A. Grolman: Handys im Service. Franzis Verlag.

C. Lüders: Mobilfunksysteme. Vogel Fachbuchverlag.

W. Fischer: Digitale Fernsehtechnik in Theorie und Praxis. Springer Verlag.

Tietze / Schenk / Gamm: Halbleiter-Schaltungstechnik, 15. Auflage.Springer Verlag 2016.

H. H. Meinke / F. W. Gundlach: Taschenbuch der Hochfrequenztechnik, 5. Auflage. SpringerVerlag, Berlin 1992.

W. Bächtold: Mikrowellenelektronik. Vieweg Verlag, Braunschweig 2002.

W. Bächtold: Mikrowellentechnik. Vieweg Verlag, Braunschweig 1999.

B. Huder Grundlagen der Hochfrequenz-Schaltungstechnik. Oldenbourg Wissenschaftsverlag, Berlin, Boston 2018.

O. Zinke / H. Brunswig: Hochfrequenztechnik I, 6. Auflage. Springer Verlag, Berlin 2000.

O. Zinke / H. Brunswig: Hochfrequenztechnik II, 5. Auflage. Springer Verlag, Berlin 1999.

ET-39 ELECTRONIC CIRCUITS 2

Module code	ET-39
Module coordination	Prof. Dr. Werner Bogner
	Nachrichtentechnik und Elektronik (NTE)
Course number and name	ET 7108 Electronic Circuits 2
Semester	7
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	German
Dozent	Röhrl, Franz

Module Objective

- Ability to analyze and apply analog semiconductor circuits of news and wireless technology

- Ability to design, to dimension and optimize circuits of news and radio technology

- Ability to integrate circuits of news and radio technology to more complex system components

- Ability to analyze and to optimize systems of communications and wireless technology

Entrance Requirements

Formally: at least 80 ETCS credits;

Content-related: circuit technology I, high-frequency electronics

Last update

Learning Content

- Transmitter, receiver, dynamics

- Passive RF circuits waveguide n-ports, filters, couplers

- RF amplifier circuits VGA, selective, broadband, power amplifier

- Oscillators and signal generators RC, LC, quartz oscillators, noise performance and frequency stability, PLL

- Mixers and frequency converters: additive and multiplicative mixer; frequency doubling; diode and transistor mixer; design and circuit implementations

Lab:
Colpitts and quartz oscillator
nonlinear simulation
switched-capacitor filter
pulse modulation (PAM & PCM)
PLL
Gilbert cell
Tube amplifier

Teaching Methods

seminar-based teaching with exercises and lab, computer simulations

Remarks

Admission requirement for the examination: Successful participation in the lab (testate).
Support through the e-learning platform

Recommended Literature

Tietze / Schenk / Gamm: Halbleiter-Schaltungstechnik, 16. Auflage. Springer-Verlag 2019.

H. H. Meinke / F. W. Gundlach: Taschenbuch der Hochfrequenztechnik, 5. Auflage. Springer-Verlag, Berlin 1992.

W. Bächtold: Mikrowellenelektronik. Vieweg Verlag, Braunschweig 2002.

W. Bächtold: Mikrowellentechnik. Vieweg Verlag, Braunschweig 1999.

B. Huder: Grundlagen der Hochfrequenz-Schaltungstechnik.Oldenbourg Wissenschaftsverlag, Berlin, Boston 2018.

E. Voges: Hochfrequenztechnik, 3. Auflage. Hüthig Verlag, Bonn 2004.

H. Heuermann: Hochfrequenztechnik. 3. Auflage, Springer Verlag, 2018.

Vetter: Schaltungstechnische Praxis. Verlag Technik 2001.

Kurz / Mathis: Oszillatoren. Hüthig-Verlag 1994.

Maas: The RF and Microwave Circuit Handbook. Artech House 1998.

Cripps: RF Power Amplifiers for Wireless Communications, 2nd edition. Artech House 2006.

Pozar: Microwave and RF Design of Wireless Systems. John Wiley & Sons 2001.

ET-40 PRINCIPLES OF INTEGRATED CIRCUITS AND SYSTEMS

Module code	ET-40
Module coordination	Prof. Dr. Günther Benstetter
	Allgemeine Elektrotechnik (AET)
Course number and name	ET 6112 Principles of Integrated Circuits and Systems
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	6/210
Language of Instruction	German

Entrance Requirements

keine

Recommended Literature

J. Albers: Grundlagen integrierter Schaltungen. Bauelemente und Mikrostrukturierung, 2. Auflage. Hanser Verlag, München 2010.

G. Gerlach / W. Dötzel: Einführung in die Mikrosystemtechnik, Hanser Verlag. München 2006.

S.M. Sze / M.K. Lee: Semiconductor devices. Physics and technology. International Student Version, 3. Auflage. Wiley & Sons, N.J, Chichester 2012.

R. Brück / N. Rizivi / A. Schmidt: Angewandte Mikrotechnik. Hanser Verlag, München 2001.

R.C. Jaeger: Introduction to Microelectronic Fabrication, 2nd edition. Prentice Hall, Upper Saddle River, New Jersey 2002.

ET-41 SYSTEM TECHNOLOGY FOR RENEWABLE ENERGY

Module code	ET-41
Module coordination	Prof. Dr. Otto Kreutzer
	Allgemeine Elektrotechnik (AET)
Course number and name	ET 6113 System Technology for Renewable Energy
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written student research project
Weight	6/210
Language of Instruction	German

Module Objective

Ability to design and sizing solar electric systems for stand-alone and grid-connected operations

Ability of the design and sizing of solar thermal plants

Determining the suitability of renewable energy systems

Entrance Requirements

keine

Learning Content

Energy situation: consumption, energy

Solar energy: radiation available, photovoltaic, grid system, grid-connected systems, solar thermal systems, solar thermal

power generation

Wind energy: structure, function and regulation of wind turbines

Geothermal energy, wave energy, hydro power plants

Recommended Literature

Veröffentlichungen des IEEE

V. Quaschning: Regenerative Energiesysteme, 9. Auflage. Carl Hanser Verlag 2015.

V. Quaschning: Erneuerbare Energien und Klimaschutz, 4. Auflage. Carl Hanser Verlag 2018.

F. Zach: Leistungselektronik, 5. Auflage. Springer/Vieweg 2015.

Sterner / Stadler: Energiespeicher, 2. Auflage. Springer/Vieweg 2017.

ET-42 INTRODUCTION TO OPTOELECTRONICS AND LASER TECHNOLOGY

Module code	ET-42
Module coordination	Prof. Dr. Franz Daiminger
	Allgemeine Elektrotechnik (AET)
Course number and name	ET 6114 Introduction to Optoelectronics and Laser Technology
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	
Language of Instruction	German

Entrance Requirements

keine

Recommended Literature

H.J. Eichler / J. Eichler: Lasers: Basics, Advances And Applications (Springer Series in Optical Sciences, Band 220), 2018.

D. Meschede: Optics, Light And Lasers: The Practical Approach To Modern Aspects Of Photonics And Laser Physics. Wiley, VCH 2017.

J. Eichler / H.J. Eichler: Laser-Bauformen, Strahlführung, Anwendungen, 7. Auflage. Springer Verlag, Berlin 2010.

D. Meschede: Optik, Licht und Laser, 3. Auflage. Vieweg & Teubner, Wiesbaden 2008.

M. Eichhorn: Laserphysik, 1. Auflage. Springer Spektrum, Berlin 2012.

H. Kull: Laserphysik, 1. Auflage, Oldenburg, München 2010.

S. Orazio: Principles of Lasers, 5. Auflage. Springer, New York 2010.

E. Hecht: Optik, 4. Auflage. Oldenburg, München 2005.

ET-43 POWER ENGINEERING PLANTS

Module code	ET-43
Module coordination	Prof. Dr. Reinhard Schlosser
	Allgemeine Elektrotechnik (AET)
Course number and name	ET 6115 Power Engineering Plants
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	6/210
Language of Instruction	German

Entrance Requirements

keine

Recommended Literature

R. Flosdorff / G. Hilgarth: Elektrische Energieverteilun,. 9. Auflage. Springer/Vieweg, Wiesbaden 2005.

ET-44 POWER SUPPLY TECHNOLOGY

Module code	ET-44
Module coordination	Prof. Dr. Günter Keller
	Allgemeine Elektrotechnik (AET)
Course number and name	ET 6116 Power Supply Technology
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	6/210
Language of Instruction	German

Module Objective

Ability of the design and dimensioning of unregulated and linearly regulated power supply circuits

Ability of the design and dimensioning switched power supply circuits

Entrance Requirements

keine

Learning Content

Terms: terminology and characteristics of power supplies

Components of power supply technology

Unregulated and linear controlled circuits

Switch mode technology

Control of switching power supplies: modeling

Various simulation controller structures

Recommended Literature

F. Zach: Leistungselektronik, Band I und Band II, 5. Auflage. Springer/Vieweg 2015.

Erickson / Maksimovic: Fundamentals of Power Electronics, second edition. Kluwer Academic Press 2001.

Schlienz: Schaltnetzteile und ihre Peripherie, 6. Auflage. Springer/Vieweg 2016.

ET-45 PRODUCTION / QUALITY ASSURANCE IN ELECTRONICS

Module code	ET-45
Module coordination	Prof. Dr. Detlef Brumbi
	Allgemeine Elektrotechnik (AET)
Course number and name	ET 7109 Production / Quality Assurance in Electronics
Semester	7
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written student research project
Weight	6/210
Language of Instruction	German

Entrance Requirements

keine

Recommended Literature

Fertigungstechnik:

R. Sautter: Fertigungsverfahren. Vogel 1997.

W. Krause: Fertigung in der Feinwerk- und Mikrotechnik. Hanser 1996.

W. Krause: Gerätekonstruktion in Feinwerktechnik und Elektrotechnik, Hanser 2000.

W. Scheel: Baugruppentechnologie der Elektronik, Teil 1: Montage. Verlag Technik 1999.

H. Hanke: Baugruppentechnologie der Elektronik, Teil 2: Leiterplatten. Verlag Technik 1994.

G. Zickert: Leiterplatten: Stromlaufplan, Layout und Fertigung. Hanser 2015.

H. Eigler / W. Beyer: Moderne Produktionsprozesse der Elektrotechnik. Expert Verlag 1996.

W. Fischer (Hrsg.): Mikrosystemtechnik. Vogel Buchverlag 2000.

C.P. Keferstein: Fertigungsmesstechnik, 8. Auflage. Vieweg+Teubner 2015.

J. F. Shackelford: Werkstofftechnologie für Ingenieure, 6. Auflage. Pearson Studium 2005.

E. Ivers-Tiffée / W. von Münch: Werkstoffe der Elektrotechnik, 10. Auflage. Vieweg+Teubner 2007.

H. Czichos (Hrsg.): HÜTTE Das Ingenieur-Wissen, 34. Auflage. Springer 2012.

G. Brechmann et al.: Elektrotechnik Tabellen Kommunikationselektronik. Westermann 1996.

Wahrscheinlichkeitstheorie/Statistik:

L. Papula: Mathematik für Ingenieure und Naturwissenschaftler Band 3. 6. Auflage. Vieweg+Teubner 2011.

B. Brinkmann: Internationales Wörterbuch der Metrologie (VIM, deutsch-englische Fassung ISO/IEC-Leitfaden 99:2007), 4. Auflage, Beuth 2012.

bzw. JCGM 200:2008: International vocabulary of metrology — Basic and general concepts and associated terms (VIM)

T. Sauerbier / W. Voß: Kleine Formelsammlung Statistik, 4. Auflage. Hanser 2008.

R. Looser: Statistische Messdatenauswertung. Franzis 2003.

U. Reinert / H. Blaschke / U. Brockstieger: Technische Statistik in der Qualitätssicherung. Springer 1999.

E. Dietrich / A. Schulze: Statistische Verfahren zur Maschinen- und Prozessqualifikation, 7. Auflage. Hanser 2014.

Qualitätssicherung:

W. Geiger / W. Kotte: Handbuch Qualität, 5. Auflage. Vieweg 2008.

G. Linß: Qualitätsmanagement für Ingenieure, 4. Auflage. Hanser 2018.

G. Linß: Qualitätssicherung – Technische Zuverlässigkeit. Hanser 2016.

H. Brüggemann / P. Bremer: Grundlagen Qualitätsmanagement, 2. Auflage. Springer-Vieweg 2015.

G. Kamiske / J.P. Brauer: Qualitätsmanagement von A bis Z, 7. Auflage. Hanser 2011.

A. Meyna / B. Pauli: Zuverlässigkeitstechnik – Quantitative Bewertungsverfahren, 2. Auflage. Hanser 2010.

A. Birolini: Zuverlässigkeit von Geräten und Systemen. Springer 1997.

A. Birolini: Reliability Engineering: Theory and Practice, 7. Auflage. Springer 2013.

A. Rahn: Handbuch der Prozess- und Lötfehler. Leuze 2014.

S. Eberlin / B. Hock: Zuverlässigkeit und Verfügbarkeit technischer Systeme. Springer-Vieweg 2014.

M. Werdich(Hrsg.): FMEA – Einführung und Moderation, 2. Auflage. Vieweg+Teubner 2012.

ET-46 COMPUTER-AIDED SIMULATION IN ELECTRICAL POWER ENGINEERING

Module code	ET-46
Module coordination	Prof. Dr. Reinhard Schlosser
	Allgemeine Elektrotechnik (AET)
Course number and name	ET 7110 Computer-Aided Simulation in Electrical Power Engineering
Semester	7
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	
Language of Instruction	German

Entrance Requirements

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Recommended Literature

R. Flosdorff / G. Hilgarth: Elektrische Energieverteilung, 9. Auflage. Springer/Vieweg, Wiesbaden 2005.