

Hochschule München  
University of Applied Sciences

Fakultät für Elektrotechnik und Informationstechnik  
Department of Electrical Engineering and Information Technology

# Bachelor of Electrical Engineering and Electromobility

27.04.2026

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## Programme Learning Outcomes

### General Programme Learning Outcomes

The Bachelor's degree programme in Electrical Engineering – Electromobility provides students with knowledge, skills and competencies through practice-oriented academic teaching that enables them to work independently as engineers in the field of electric drive technology and also in classical fields of electrical engineering. In this way, graduates can follow and actively shape the rapidly advancing technical development of electrical engineering, especially in the field of electric drive technology. They are able to work together with specialists in the automotive environment whose career path is not based on an electrical engineering education. The following essential knowledge is conveyed:

- Strong knowledge of the basics of mathematics and physics
- All basics of electrical engineering and information technology
- Advanced knowledge in electric drive technology
- Basic knowledge of relevant non-technical topics, in particular economics and law as well as project management.

Students also acquire special skills in electric drive technology:

- They are able to select suitable tools and procedures for solving technical problems.
- They know how to solve technical problems or tasks in a targeted manner.
- They are able to use and operate technical devices.
- They are familiar with relevant software tools (e.g. simulation).

Through their studies, students acquire technical, methodological and social skills. The following expertise should be acquired during the programme:

- Students recognize complex correlations, even across disciplines.
- They can analyse technical problems, especially in electric drive technology.
- They can create suitable solution concepts for these problems.

The main methodological skills to be mentioned are:

- Students can independently select, obtain and evaluate the information necessary to solve a problem.
- The students also have an awareness of non-technical issues and can in particular recognize the effects of technology on the environment and society and make them tolerable, i.e. assess the consequences of technology.

The following social skills should be acquired:

- Students can communicate facts and work results appropriately and present them in an understandable manner.
- Students can work productively in project teams and, if necessary, also take on the management of project teams.

### Supplementary Learning Outcomes of Dual Students

Beyond the learning objectives achieved at the university, dual students acquire practical technical, methodological, and organisational competences that are directly anchored in real operational processes. They deepen their understanding of industrial technologies, standards, development, and production processes by applying content known from the university in specific projects, employing systematic analysis and problem-solving strategies. Through active participation in technical teams, they develop strong communication and social skills, which are essential for the execution of interdisciplinary tasks. Continuous engagement with operational requirements strengthens the ability to take technical decisions while considering economic efficiency, safety, the environment, and social impacts. At the same time, the parallel management of studies and practice fosters high levels of self-organisation, responsibility, and professional proficiency, facilitating the transition into the fields of activity within the engineering profession.



# Technische Informatik 1

## Modul

<b>Module Name</b>	Technische Informatik 1
<b>Module Level</b>	Bachelor
<b>Credit Points per Module</b>	7
<b>Module Coordinator</b>	Dr. Christian Kißling

## General Information about the Course

<b>German Title</b>	Technische Informatik 1
<b>English Title</b>	Computer Engineering 1
<b>Code</b>	EG252 – Compulsory Subject
<b>Semester</b>	2
<b>Frequency of C. Offer</b>	normally every semester
<b>Credit Points per Course</b>	7
<b>Course Coordinator</b>	Dr. Christian Kißling
<b>Hours per Week</b>	6
<b>Teaching Method</b>	Seminaristischer Unterricht mit integriertem lab exercise (5 SU + 1 Pra)
<b>Workload</b>	70 SU + 14 Pra + 126 preparation/post-processing = 210 hours
<b>Language</b>	german
<b>Degree Programs</b>	EI/RE/EM
<b>Media</b>	blackboard, flipchart, overhead projector, video projector, e-learning

## Lecturers

Dr. Christian Kißling (Modulverantw.), Dr. Joachim Schramm, Dr. Klaus Ressel, Dr. Eric-Roger Brücklmeier, Dr. habil. Alfred Schöttl, LbA Walter Tasin M. Sc., Dr. Gerhard Schillhuber, Dr. Monika Mühlbauer, Dr. Marek Galek, Dr. Felix Miller, Dr. Ulrich Unterhinninghofen, Dr. Markus Plattner, Dr. Clemens Hage

## Recommended Requirements

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## Module Objectives and Planned Learning Outcomes

Students understand basic computer architectures and they are familiar with the use of microcomputers. They know properties and handling of a special 8 bit microcomputer and they are able to program basic software routines.

Furthermore students are able to transfer and to solve simple tasks from the digital area with a microcomputer. Students know basic definitions of information theory, properties of different codes, logical operators and they are familiar with way how to design and analyze digital circuits.

They know properties of combinatorial and sequential circuits.

They are able to make simple calculations with binary numbers, to convert numbers into different numbering systems and they can transform and simplify binary equations using logical theorems.

Furthermore, students can realize and analyze combinatorial circuits.

## Contents

- Basic computer architectures (Von Neumann, Harvard)
- Special properties, handling and use of an 8 bit microcomputer (structure and internal components, handling, design tools. Use of I/O-ports: connection of components, internal mode of operation)
- Programming: Basics of microcomputer programming, variables, data structures, control structures, implementation of simple problems. Processing of examples
- Basics of information theory (information content, entropy)

- Codes (Numerical and alphanumeric codes, codes of variable length, error detection)
- number representation (Integer, binary complement, floating point, transformation)
- Arithmetic with binary numbers (basic arithmetics, implementation)
- Boolean algebra (logical operators, logical theorems)
- Minimization of boolean equations (graphical and tabular)
- description, analysis and synthesis of combinatorial circuits (decoder, coder, multiplexer, demultiplexer, arithmetic circuits),
- Digital storage elements (flipflops, register).

## Literature

Schmitt: Mikrocomputertechnik mit Controllern der Atmel AVR-RISC-Familie, Oldenbourg Verlag

Spanner: AVR-Mikrocontroller in C programmieren, Franzis Verlag

Bremer: Digitaltechnik interaktiv!, Springer-Lehrbuch

Lipp: Grundlagen der Digitaltechnik, Oldenbourg Verlag München Wien

Siemers, Sikora: Taschenbuch der Digitaltechnik, Fachbuchverlag Leipzig

Urbanski, Woitowitz: Digitaltechnik, Springer-Lehrbuch

Ward, Halstead: Computation Structures, MIT-Press

Plate: Digitaltechnik, <http://www.netzmafia.de/skripten/digitaltechnik/>

## Examination

**Method and Duration of Examination:** schriftliche Prüfung 90 min + FrwL (0% Bonus)

# Technische Informatik 3

## Modul

<b>Module Name</b>	Technische Informatik 3
<b>Module Level</b>	Bachelor
<b>Credit Points per Module</b>	8
<b>Module Coordinator</b>	Dr. Benjamin Kormann

## General Information about the Course

<b>German Title</b>	Technische Informatik 3
<b>English Title</b>	Computer Engineering 3
<b>Code</b>	EG492 – Compulsory Subject
<b>Semester</b>	4
<b>Frequency of C. Offer</b>	normally every semester
<b>Credit Points per Course</b>	8
<b>Course Coordinator</b>	Dr. Benjamin Kormann
<b>Hours per Week</b>	7
<b>Teaching Method</b>	Seminaristischer Unterricht mit integriertem lab exercise (4,33 SU + 2,67 Pra)
<b>Workload</b>	61 SU + 37 Pra + 142 preparation/post-processing = 240 hours
<b>Language</b>	german
<b>Degree Programs</b>	EI/EM
<b>Media</b>	blackboard, flipchart, overhead projector, video projector, e-learning

## Lecturers

Dr. Benjamin Kormann (Modulverantw.), Dr. Manfred Gerstner, Dr. Klaus Ressel, Dr. Eric-Roger Brücklmeier, Dr. habil. Alfred Schöttl, LbA Walter Tasin M. Sc., Dr. Gerhard Schillhuber, Dr. Christian Kißling, Dr. Felix Miller, Dr. Fabian Flohr, Dr. Ulrich Unterhinninghofen, Dr. Clemens Hage

## Recommended Requirements

Computer Engineering 1 and 2

## Module Objectives and Planned Learning Outcomes

### 1. Programming

The students know of the most important concepts of the programming language Python. They understand the notion of a variable, an instance, and a value. They are aware of the data structures dictionary, tuple, list, set and their typical operations. The students are able to apply these data structures and their operations to problems.

The students are able to identify and implement variables, their data structure, and the necessary operational sequence in simple problems. The students can structure programs by application of functions and modules. They know of the most important concepts of object-oriented programming. They are able to structure and recycle problem solutions by designing class hierarchies.

The students know of selected libraries in the areas basic programming (e. g. strings, files), advanced techniques (e. g. threads, networks, XML files) and applications (e. g. matrices, graphics, GUI).

### 2. Embedded Systems

The student possess a deep understanding of the functional principle of modern embedded systems. They know how to program hardware oriented and can optimize a system with respect to resources and robustness. They can utilize an operating system on a micro controller.

## Contents

### Programming

#### Introduction

- The interactive shell
- Compiling and running a program

#### Basic data types and operations on them

- Variables and simple data types
- Operators, functions, methods and attributes
- sequential data types, directories and sets

#### Expressions

#### Flow control

- Alternatives and loops
- Comprehensions
- Functions, argument lists, recursion, lambda expressions

#### Code structurizing

- Modules and imports
- Packages

#### Object orientation

- Concept, notion of class, inheritance, static and private elements, abstract elements
- Standard methods, attributes, type checking, operator overloading

#### Libraries

- built-in libraries (selection)
- mathematics, strings, files, XML-files, numpy
- selection further libraries, e. g. scipy, matplotlib

#### Advances concepts

- context managers
- exceptions

#### Introduction to GUIs

### Embedded systems

- Comparison of different microcontrollers
- Introduction to a microcontroller operating system
- Hardware-oriented programming of a microcontroller with an operating system

## Literature

<http://docs.python.org/3>

[http://www.python-course.eu/python3\\_course.php](http://www.python-course.eu/python3_course.php)

J. Ernesti, P. Kaiser; Python 3: Das umfassende Handbuch: Sprachgrundlagen, Objektorientierung, Modularisierung. Rheinwerk Computing 2015

Bernd Klein; Einführung in Python 3: Für Ein- und Umsteiger, Carl Hanser Verlag GmbH & Co. KG 2014

Thomas Theis; Einstieg in Python: Ideal für Programmieranfänger geeignet (Galileo Computing). Galileo Computing 2014

## Examination

**Method and Duration of Examination:** schriftliche Prüfung 90 min + FrwL (0 % Bonus)

# Energiespeicher

## Modul

<b>Module Name</b>	Energiespeicher
<b>Module Level</b>	Bachelor
<b>Credit Points per Module</b>	5
<b>Module Coordinator</b>	Dr. Oliver Bohlen

## General Information about the Course

<b>German Title</b>	Energiespeicher
<b>English Title</b>	Energy Storage
<b>Code</b>	RM671 – Compulsory Subject
<b>Semester</b>	6
<b>Frequency of C. Offer</b>	normally every semester
<b>Credit Points per Course</b>	5
<b>Course Coordinator</b>	Dr. Oliver Bohlen
<b>Hours per Week</b>	4
<b>Teaching Method</b>	Seminaristischer Unterricht mit integriertem lab exercise (3 SU + 1 Pra)
<b>Workload</b>	42 SU + 14 Pra + 94 preparation/post-processing = 150 hours
<b>Language</b>	german
<b>Degree Programs</b>	RE/EM
<b>Media</b>	blackboard, flipchart, overhead projector, video projector, e-learning

## Lecturers

Dr. Oliver Bohlen (Modulverantw.), N.N.

## Recommended Requirements

Physics, Fundamentals of Electrical Engineering

## Module Objectives and Planned Learning Outcomes

The students are familiar with the most important storage technologies and can classify them in terms of their properties and assign them to different applications. They can calculate important parameters such as energy densities and power performance. Students can design battery systems using data sheets. They are familiar with measuring methods in the frequency and time domain and can practically implement and evaluate the latter. The students know simple electrical and thermal models of battery storage system as well as model-based diagnostic procedures and can implement them in a simulation environment and parameterize them.

## Contents

Technological overview of various battery technologies, important parameters (energy density, power density, rated voltage, capacity), design of battery systems (series circuit, parallel circuit, conductivity, energy content, aging, cycle operation), use of batteries in various applications (stationary applications, traction applications, tools, and portable media), battery monitoring, and energy management (measuring devices, supervisory ICs, state of charge, state of health), battery diagnosis (measuring methods, test methods, impedance measurement, capacity measurement, standards), operation of energy storage systems (charging process, temperature management, safety aspects).

## Literature

- Jossen, A., Weydanz, W., Moderne Akkumulatoren richtig einsetzen, Inge Reichardt Verlag, 2006
- Linden, D., Reddy, T. B. (ed.), Handbook of Batteries, McGraw-Hill Professional, 2001

## Examination

**Method and Duration of Examination:** schriftliche Prüfung 90 min + FrwL (max. 10 % Bonus, Ergänzende Dokumentation zu den Inhalten des Moduls)

# Projekt Elektromobilität

## Modul

<b>Module Name</b>	Projekt Elektromobilität
<b>Module Level</b>	Bachelor
<b>Credit Points per Module</b>	5
<b>Module Coordinator</b>	Dr. Dirk Hirschmann

## General Information about the Course

<b>German Title</b>	Projekt Elektromobilität
<b>English Title</b>	Project in Electromobility
<b>Code</b>	EM681 – Compulsory Subject
<b>Semester</b>	6
<b>Frequency of C. Offer</b>	normally every semester
<b>Credit Points per Course</b>	5
<b>Course Coordinator</b>	Dr. Dirk Hirschmann
<b>Hours per Week</b>	4
<b>Teaching Method</b>	project-based course (4 Proj)
<b>Workload</b>	150 Proj = 150 hours
<b>Language</b>	german
<b>Degree Programs</b>	EM
<b>Media</b>	blackboard, flipchart, overhead projector, video projector, e-learning

## Lecturers

Dr. Dirk Hirschmann (Modulverantw.), Dr. Oliver Bohlen, Dr.-Ing. Christoph M. Hackl

## Recommended Requirements

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## Module Objectives and Planned Learning Outcomes

Students deepen their knowledge in both electromobility and project management through the practical application of the knowledge acquired in previous semesters.

Students are able to plan, implement, and present an electrical engineering project collaboratively in a team using appropriate methods, taking into account non-technical constraints. They are familiar with the fundamental procedures for planning and executing a development project and are proficient in project management and coordination within a team.

Upon completion of this module, students can apply the relevant development tools for a given task and independently familiarize themselves with new topics. They can assess the consequences of unforeseen events, such as defective devices, malfunctions, and component delivery difficulties, and adjust the project plan accordingly. In the case of malfunctions, students analyze the error and its possible causes until the fault is identified and resolved. During the design review and during the final presentation at the end of the semester, students practice presenting technical information and defending their results in technical discussions with other students and teachers.

## Contents

Assignment: The selection is made from a list of project topics proposed by the professors.

The module sticks to the approach commonly used in industry for addressing complex projects. Each assignment includes suitable elements from the following spectrum:

System Design: Defining requirements; developing solution concepts; evaluating solution alternatives; demonstrating selected approaches; developing, implementing, and testing solutions; and commissioning.

Project Management: Setting up, planning, monitoring, controlling, and completing the project; documentation and change management procedures.

## Dual Degree Students

Students in the dual study programs *combined degree programme* (Verbundstudium) or *academic degree programme with intensive in-company training* (Studium mit vertiefter Praxis) are expected to identify potential project topics within their partner company during the practical phases preceding their sixth semester and discuss them with their internal supervisors. These topic proposals will be discussed and ultimately incorporated into the *Projekt Elektromobilität*.

## Literature

Je nach Projekt geeignete Fachliteratur

## Examination

**Method and Duration of Examination:** Modularbeit (gemäß Vorgaben zu Semesterbeginn), Hinweis: unbenoteter Leistungsnachweis

# Analog Integrated Circuit Design

## Modul

<b>Module Name</b>	Analog Integrated Circuit Design
<b>Module Level</b>	Bachelor
<b>Credit Points per Module</b>	5
<b>Module Coordinator</b>	Dr. Michael Krämer

## General Information about the Course

<b>German Title</b>	Analog Integrated Circuit Design
<b>English Title</b>	Analog Integrated Circuit Design
<b>Code</b>	WF033 – Required Elective Subject
<b>Semester</b>	6/7
<b>Frequency of C. Offer</b>	normally in summer semester
<b>Credit Points per Course</b>	5
<b>Course Coordinator</b>	Dr. Michael Krämer
<b>Hours per Week</b>	4
<b>Teaching Method</b>	Seminaristischer Unterricht mit integriertem lab exercise (3 SU + 1 Pra)
<b>Workload</b>	42 SU + 14 Pra + 94 preparation/post-processing = 150 hours
<b>Language</b>	Englisch oder Deutsch
<b>Degree Programs</b>	EI/RE/EM/DS
<b>Media</b>	blackboard, video projector, e-learning

## Lecturers

Dr. Michael Krämer (Modulverantw.), Prof. Dr. Christian Munker

## Recommended Requirements

Basic knowledge of CMOS transistors, single stage transistor amplifiers and operational amplifiers, analysis methods for electrical networks, circuit simulation

## Module Objectives and Planned Learning Outcomes

The students are able to understand, analyze, design, and verify integrated analog circuits based on CMOS transistors. This includes the complete design process, from simplified manual analysis of the circuit, through entering it into appropriate EDA software, simulating the circuit, creating the layout, to final verification (DRC, LVS, etc.) before tapeout in an integrated sub-micron CMOS technology. The students will become familiar with both the essential building blocks of modern integrated analog CMOS circuits (such as cascode stages, differential amplifiers, current mirrors, OTAs, bandgap references, etc.) and the typical design process based on open-source EDA software.

## Contents

### Analog Integrated Circuit Design:

- Introduction to the design flow for analog integrated circuits
- Presentation of the open-source toolchain
- Introduction to the exemplary 130nm Skywater CMOS process

### Circuit Design / Basic Building Blocks:

- MOSFET transistors: large-signal and small-signal modeling, layout
- Basic amplifier circuits, cascode stage
- Passive and active current mirrors, OTAs

- Differential pair
- Operational amplifiers and operational amplifier architectures
- Current/voltage references (bandgap reference)
- Noise in electronic circuits

**Integrated Realization of the Circuit:**

- Layout and layout techniques
- Post-layout simulation / parasitic extraction
- Verification (DRC, LVS)
- Submission for fabrication (tapout)

**Literature**

Razavi, Behzad: „Design of Analog CMOS Integrated Circuits“, 2nd ed., 2017.

**Examination**

**Method and Duration of Examination:** Präsentation (50 %) und mündliche Prüfung (50 %, 20 min) + FrwL (max. 10 % Bonus, Ergänzende Dokumentation zu den Inhalten des Moduls)

# Betriebsmittel und Diagnostik in der elektrischen Energietechnik

## Modul

<b>Module Name</b>	Betriebsmittel und Diagnostik in der elektrischen Energietechnik
<b>Module Level</b>	Bachelor
<b>Credit Points per Module</b>	5
<b>Module Coordinator</b>	Dr. Stephanie Uhrig

## General Information about the Course

<b>German Title</b>	Betriebsmittel und Diagnostik in der elektrischen Energietechnik
<b>English Title</b>	Assets and Diagnostics in Power Engineering
<b>Code</b>	WF039 – Required Elective Subject
<b>Semester</b>	6/7
<b>Frequency of C. Offer</b>	abhängig vom Bedarf, kein fester Turnus
<b>Credit Points per Course</b>	5
<b>Course Coordinator</b>	Dr. Stephanie Uhrig
<b>Hours per Week</b>	4
<b>Teaching Method</b>	Seminaristischer Unterricht mit integriertem lab exercise (3 SU + 1 Pra)
<b>Workload</b>	42 SU + 14 Pra + 94 preparation/post-processing = 150 hours
<b>Language</b>	german
<b>Degree Programs</b>	EI/RE/EM/DS
<b>Media</b>	blackboard, flipchart, overhead projector, video projector, e-learning

## Lecturers

Dr. Stephanie Uhrig (Modulverantw.), N.N.

## Recommended Requirements

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## Module Objectives and Planned Learning Outcomes

The students have a sound knowledge of the basic electrical, dielectric, mechanical and thermal stresses and understand how these are taken into account within the design of equipment in power engineering. Furthermore, they have an overview of essential components of the power grid and can justify their stress-related designs and identify weak points. They are able to essentially design equipment for given boundary conditions. Students are familiar with diagnostic procedures for condition assessment of equipment and will be able to interpret their results.

## Contents

Overview: Equipment in power engineering

- o Differences in voltage levels
- o Requirements regarding reliability and service life

Stresses on equipment

- o Insulation coordination
- o Long-term stable contacts (basics, models, contact aging)
- o Mechanical stress
- o Thermal stress
- o Arc faults

Equipment

- o Transformers (e.g. basic design, core designs, winding types and vector groups, insulation design, on-load tap-changers, bushings)
- o Switchgear (construction, arrangement, differences with regard to voltage level)
- o circuit breakers (based on arc quenching principles), as well as disconnectors and earthing switches
- o Current and voltage transformers

- o Surge arresters
  - o Overhead lines and cables
- Diagnostics
- o Definition of service life and introduction of aging mechanisms
  - o Dielectric measurement techniques such as tan delta measurements and dielectric spectroscopy
  - o Partial discharge measurement techniques
  - o Chemical analysis
  - o Frequency response analysis
- Aspects of asset management
- o Age structure in the German and European interconnected grid
  - o Reliability and risk assessment
  - o Maintenance strategies and consideration of economic efficiency

## Literature

- A. J. Schwab: Elektroenergiesysteme, Springer, 2022 D.  
D. Oeding, B. R. Oswald: Elektrische Kraftwerke und Netze, Springer Vieweg, 2017  
K. Heuck, K. Dettmann, D. Schulz: Elektrische Energieversorgung, Springer, 2013  
S. Kämpfer, G. Kopatsch: ABB Schaltanlagen Handbuch, Cornelsen Verlag, 2012  
G. Balzer, Ch. Schorn: Asset Management für Infrastrukturanlagen - Energie und Wasser, Springer Vieweg, 2020

## Examination

**Method and Duration of Examination:** mündliche Prüfung 20 min

# Betriebssystem UNIX/Linux

## Modul

<b>Module Name</b>	Betriebssystem UNIX/Linux
<b>Module Level</b>	Bachelor
<b>Credit Points per Module</b>	5
<b>Module Coordinator</b>	Dr. Manfred Gerstner

## General Information about the Course

<b>German Title</b>	Betriebssystem UNIX/Linux
<b>English Title</b>	Operating System UNIX/Linux
<b>Code</b>	WF020 – Required Elective Subject
<b>Semester</b>	6/7
<b>Frequency of C. Offer</b>	abhängig vom Bedarf, kein fester Turnus
<b>Credit Points per Course</b>	5
<b>Course Coordinator</b>	Dr. Manfred Gerstner
<b>Hours per Week</b>	4
<b>Teaching Method</b>	Seminaristischer Unterricht mit integriertem lab exercise (3 SU + 1 Pra)
<b>Workload</b>	42 SU + 14 Pra + 94 preparation/post-processing = 150 hours
<b>Language</b>	german
<b>Degree Programs</b>	EI/RE/EM/DS
<b>Media</b>	blackboard, video projector, e-learning

## Lecturers

Dr. Manfred Gerstner (Modulverantw.), LbA Walter Tasin M. Sc.

## Recommended Requirements

Basic programming capabilities (e.g. by Computer Engineering 1-3)

## Module Objectives and Planned Learning Outcomes

### Expertise

- Understanding of the basics, principles, working methods of Unix-like operating systems
- Know-how about distro selection, installation and configuration of a Linux system
- Programming skills for developing Linux based applications
- Productive work and profitable use of a Linux platform in everyday life
- Understanding of the application of Linux in the field of electrical engineering and beyond

### Methodological competence

- Ability to analyze and solve problems in the field of software
- Knowledge of proven methods and procedures in the development of software, e.g. for the Raspberry Pi
- Ability to understand and implement complex technical concepts
- Efficient and ergonomic use of standard Unix tools

### Social skills

- Teamwork and cooperation with other students in projects
- Communication skills to exchange ideas and technical knowledge
- Ability to present technical concepts and results in an understandable way
- Ability to give constructive feedback and collaborate in a learning community
- Respectful collaboration and cultural sensitivity in dealing with different backgrounds and perspectives

## Self-competence

- Time management and effective organization of one's own learning process
- Ability to independently acquire knowledge and work independently
- Meeting deadlines and taking responsibility for completing tasks

## Contents

1. Structure and methods of operating systems; Unix, Linux, distros
2. first steps with command line interface, getting help (-help, man-pages)
3. File systems from user perspective, from OS perspective; roles, rights, user administration; Devices in /dev
4. Process management, memory isolation, time slots, scheduling, IPC
5. bashscript (if, while, for,...) variables, path expansion, regular expressions
6. Miscellaneous, e.g. boot process, systemd, IT security, archiving and backup strategies, selection, installation and set up of distros

## Literature

Linus Torvalds: Just for Fun, Hanser-Verlag

A. Achilles: *Betriebssysteme: Eine Kompakte Einführung mit Linux*, eXamen.press, 2005

W. Stallings: *Operating Systems: Internals and Design Principles*, Global Edition, 2017

M. Hausenblas: *Learning Modern Linux: A Handbook for the Cloud Native Practitioner*, O'Reilly, 2022

J. Friedl: *Mastering Regular Expressions*, O'Reilly, 2006

J. Goyvaerts, S. Levithan: *Regular Expressions Cookbook: Detailed Solutions in Eight Programming Languages*, 2012

## Examination

**Method and Duration of Examination:** schriftliche Prüfung 90 min oder mündliche Prüfung 20 - 30 min

# Business and Technical English in Electrical Engineering

## Modul

<b>Module Name</b>	Business and Technical English in Electrical Engineering
<b>Module Level</b>	Bachelor
<b>Credit Points per Module</b>	5
<b>Module Coordinator</b>	Dr. Nicole Brandstetter

## General Information about the Course

<b>German Title</b>	Business and Technical English in Electrical Engineering
<b>English Title</b>	Business and Technical English in Electrical Engineering
<b>Code</b>	WF036 – Required Elective Subject
<b>Semester</b>	6/7
<b>Frequency of C. Offer</b>	abhängig vom Bedarf, kein fester Turnus
<b>Credit Points per Course</b>	5
<b>Course Coordinator</b>	Dr. Nicole Brandstetter
<b>Hours per Week</b>	4
<b>Teaching Method</b>	Seminar (mit z.B. Präsentationen/Referaten) (4 S)
<b>Workload</b>	56 S + 94 preparation/post-processing = 150 hours
<b>Language</b>	english
<b>Degree Programs</b>	EI/RE/EM/DS
<b>Media</b>	blackboard, flipchart, overhead projector, video projector, e-learning

## Lecturers

Dr. Nicole Brandstetter (Modulverantwortw.), Ana Schaumburger

## Recommended Requirements

Knowledge of English at level B1

## Module Objectives and Planned Learning Outcomes

- Professional competence

Upon completion of that course, students are able to communicate confidently in English in various situations of their future professional life. For that purpose they enhance their oral and written communication skills by training how to use English in business contexts correctly according to the situation and to the audience (level B2).

- Methodological competence

Students are able to explore new lexical fields and topics and to reflect their own learning process on a methodological basis. Thereby students get to know strategies to avoid mistakes in using English.

- Self-competence

Students compare their conduct in various communicative situations and consequently discuss strategies of handling those situations professionally. In addition, they enhance their written competence in English.

- Social competence

Students verbalise topics adequately and present results confidently with regard to the context and the audience.

## Contents

In this seminar students train their oral competence in English in various communicative situations (formal introductions, small talk, social English, job interview, telephone calls). Furthermore, they practise how to write technical instructions, process descriptions and different forms of professional business correspondence (emails, memos) according to the given situation. For that purpose, necessary grammatical structures and specific vocabulary and

expressions are trained. Moreover, students learn how to put together successfully their individual documents for a job application (CV, covering letter) and thereby get to know different corporate structures.

## Literature

- Nachschlagewerke zur englischen Sprache
  - Longman Business English Dictionary. Longman, 2007
  - Oxford Advanced Learner's Dictionary. Oxford University Press, 2015
  - Oxford Business English Dictionary. Oxford University Press, 2005
- Fachliteratur zur englischen Sprache
  - Business Spotlight. Planegg: Spotlight Verlag
  - Duckworth, Michael. Business Grammar & Practice. Oxford: Oxford UP, 2013
  - Emmerson, Paul. Business English Vocabulary Builder. The words & phrases you need to succeed. London: Macmillan, 2009
  - Emmerson, Paul. Business English Grammar Builder. Second Edition. Clear explanations for real situations. London: Macmillan, 2010
  - Ibbotson, Mark. Cambridge English for Engineering. Cambridge: Cambridge UP, 2008
  - Ibbotson, Mark. Professional English in Use. Cambridge: Cambridge UP, 2010
  - McCarten, Jeanne; McCarthy, Michael. Grammar for Business. Stuttgart: Klett, 2010
  - Murphy, Raymond. English grammar in use: A self-study reference and practice book for intermediate students. Cambridge: Cambridge University Press, 2012
  - Strutt, Peter. Market Leader – Essential Business Grammar and Usage. Harlow: Pearson Education Limited, 2010
  - Ungerer, F.; Meier, G. E. H.; Schäfer, K.; Lechler, S. B. A Grammar of Present-Day English. Stuttgart: Klett, 2009

## Examination

**Method and Duration of Examination:** Modularbeit (50 %, E-Portfolio gemäß Vorgabe zu Semesterbeginn) + mündliche Prüfung 20 min (50 %)

## Fakultätsübergreifendes interdisziplinäres Projekt

### Modul

<b>Module Name</b>	Fakultätsübergreifendes interdisziplinäres Projekt
<b>Module Level</b>	Bachelor
<b>Credit Points per Module</b>	5
<b>Module Coordinator</b>	Dr. habil. Norbert Geng

### General Information about the Course

<b>German Title</b>	Fakultätsübergreifendes interdisziplinäres Projekt
<b>English Title</b>	Multidisciplinary Project Across Several Faculties
<b>Code</b>	WF035 – Required Elective Subject
<b>Semester</b>	6/7
<b>Frequency of C. Offer</b>	abhängig vom Bedarf, kein fester Turnus
<b>Credit Points per Course</b>	5
<b>Course Coordinator</b>	Dr. habil. Norbert Geng
<b>Hours per Week</b>	4
<b>Teaching Method</b>	project-based course (4 Proj)
<b>Workload</b>	150 Proj = 150 hours
<b>Language</b>	german
<b>Degree Programs</b>	EI/RE/EM
<b>Media</b>	blackboard, flipchart, overhead projector, video projector, e-learning

### Lecturers

Dr. habil. Norbert Geng (Modulverantw.), Dr. Simon Schramm, Dr. Stephanie Uhrig, Dr. Georg Kerber

### Recommended Requirements

Project Management, Fundamentals of Semester 1-4

### Module Objectives and Planned Learning Outcomes

The students deepen their knowledge in the field of electrical engineering as well as in the area of project management by working on a specific task within a larger technical project.

The students are able to plan a project in the field of electrical engineering or adjacent technical areas using appropriate methods, to realize technical solutions and to present the results, taking into account non-technical boundary conditions if necessary. They are able to deal with a technical problem using appropriate methods, if necessary interdisciplinary and work-sharing in the team.

Due to the interdisciplinary offer, students are also able to work with non - electrical technicians in a technical project.

### Contents

The „Interdisciplinary Teaching Project“ takes place as a project across faculty boundaries with students from various technical and non-technical faculties of the Hochschule München (HM). It is supervised by professors of the HM. Further details about the content of the project, the resulting tasks and also the examination mode can be obtained from the teachers of the relevant teaching project.

The chosen teaching format is characterized by the fact that students are taught competencies through problem-oriented learning at practice-oriented and interdisciplinary tasks.

Important instructions:

The offer of interdisciplinary teaching projects will be announced university-wide in time before the beginning of the semester.

The project can in principle be chosen in any semester. A credit to the Bachelor's certificate is currently only provided in the semesters 6/7 as a WP2 module.

In order to be able to ensure the (electrical) technical reference of the assignment within the teaching project, a permission from the examination board is required if the teaching project is to be counted as a WP2 module (replacing one of the other possible WP2 modules).

## Literature

abhängig vom konkreten Projekt

## Examination

**Method and Duration of Examination:** nach Vorgabe der Prüfer:innen (z.B. Modularbeit, Präsentation, mündliche Prüfung)

## Labor-Projekt

### Modul

<b>Module Name</b>	Labor-Projekt
<b>Module Level</b>	Bachelor
<b>Credit Points per Module</b>	5
<b>Module Coordinator</b>	Dr. habil. Norbert Geng

### General Information about the Course

<b>German Title</b>	Labor-Projekt
<b>English Title</b>	Laboratory Project
<b>Code</b>	WF034 – Required Elective Subject
<b>Semester</b>	6/7
<b>Frequency of C. Offer</b>	normally every semester
<b>Credit Points per Course</b>	5
<b>Course Coordinator</b>	Dr. habil. Norbert Geng
<b>Hours per Week</b>	4
<b>Teaching Method</b>	project-based course (4 Proj)
<b>Workload</b>	150 Proj = 150 hours
<b>Language</b>	german/english
<b>Degree Programs</b>	EI/RE/EM
<b>Media</b>	blackboard, flipchart, overhead projector, video projector, e-learning

### Lecturers

Dr. habil. Norbert Geng (Modulverantw.), Dr. Joachim Schramm, Dr. Arne Striegler, LbA Walter Tasin M. Sc.

### Recommended Requirements

Project Management, Fundamentals of Semester 1-4

### Module Objectives and Planned Learning Outcomes

The students deepen their knowledge in the field of electrical engineering as well as the area of project management by working on a specific task within a larger technical project.

Through their participation in a larger research project, students get familiar with scientific methods.

The students are able to plan a project in the field of electrical engineering or neighboring areas using appropriate methods, to realize technical solutions and to present the results, taking into account non-technical boundary conditions if necessary. They are able to deal with a technical problem with appropriate methods, if necessary interdisciplinary and work-sharing in the team.

By working together with the other project participants, the students improve their competence for communication in the team.

### Contents

The laboratory project takes place in a laboratory of FK04 and is supervised by a faculty professor. The topic is defined by the supervising professor, and in many cases is a partial aspect of a larger R & D project. Even if the R & D project is carried out in cooperation with external partners, the work within the framework of this module has to take place in the laboratories of the university.

The task is defined by the spectrum of the technical focus and R & D projects of the faculties' laboratories and enables the students to apply and deepen their knowledge with appropriate guidance by the supervisor. In this way, the students are enabled to work independently on the problem solution together with others. The laboratory project is based on the usual practice in the industrial environment when dealing with complex tasks.

The laboratory project is a module, which is included in the list of the so-called WP2 modules (compulsory modules) (see study plan), which is equivalent to the other WP2 modules.

## Literature

Geeignete Fachliteratur abhängig vom konkreten Projekt (Hinweise des Dozenten oder Literatursuche im Internet bzw. in der Bibliothek).

Schelle Heinz, Projekte zum Erfolg führen - Projektmanagement systematisch und kompakt, München, Dt. Taschenbuch-Verlag, 2010

Jenny Bruno, Projektmanagement - das Wissen für den Profi, Zürich, vdf, Hochschulverlag an der ETH Zürich

Roger P. Wormwood: The World Before the Internet and Other Frightening Tales,  
Paris (Texas), SNAFU Publishing Group, 2009

## Examination

**Method and Duration of Examination:** Modulararbeit + Präsentation, gemäß Vorgaben beim Projektstart

# Network Security

## Modul

<b>Module Name</b>	Network Security
<b>Module Level</b>	Bachelor
<b>Credit Points per Module</b>	5
<b>Module Coordinator</b>	

## General Information about the Course

<b>German Title</b>	Network Security
<b>English Title</b>	Network Security
<b>Code</b>	WF009 – Required Elective Subject
<b>Semester</b>	6/7
<b>Frequency of C. Offer</b>	abhängig vom Bedarf, kein fester Turnus
<b>Credit Points per Course</b>	5
<b>Course Coordinator</b>	
<b>Hours per Week</b>	4
<b>Teaching Method</b>	Seminaristischer Unterricht mit integriertem lab exercise (3 SU + 1 Pra)
<b>Workload</b>	42 SU + 14 Pra + 94 preparation/post-processing = 150 hours
<b>Language</b>	Englisch
<b>Degree Programs</b>	EI/RE/EM/DS
<b>Media</b>	blackboard, flipchart, overhead projector, video projector, e-learning

## Lecturers

(Modulverantw.), N.N.

## Recommended Requirements

fundamental programming skills (e.g. from Computer Engineering 1-3), English Workshop

## Module Objectives and Planned Learning Outcomes

Provides detailed knowledge of network security, the fundamentals of cryptography, and the possibilities and limitations to ensure the various security requirements in communication. Possible weaknesses of networks are shown from a hackers perspective. The students are then able to draw conclusions about the possibilities of designing secure products and networks, build them up accordingly and explain the results.

## Contents

security-requirements, fundamentals of cryptography, identification and authentication, PKI (public key infrastructures), attack methodology and scenarios, computer and network security, software reliability, risk analysis, design of protective measures.

Recommended special requirements: TCP / IP knowledge, protocol analysis, basics of network administration, routing and firewalls (corresponds to the first part of the lecture computer networks, which can be visited in parallel).

## Literature

Caswell, Hewlett; Snort Users Manual, [www.snort.org](http://www.snort.org)  
 Fyodor; nmap Documentation, <http://www.insecure.org/nmap.html>  
 Gerloni et.al; Praxisbuch für Linux-Server und -Netze; Hanser Verlag  
 Kyas, a Campo; IT-Crackdown, Sicherheit im Internet, mitp Verlag  
 Nash et. al; PKI, E-Security implementieren, mitp Verlag  
 Northcutt et. al; Inside Network Perimeter Security, New Riders  
 Northcutt, Novak; Network Intrusion Detection, New Riders

Peterson, Davie; Computer Networks, Morgan Kaufman, dt. Ausgabe bei Dpunkt  
Plate; Sicherheit in Computernetzen, <http://www.netzmafia.de/skripten/index.html>  
Russell et. al; Hack Proofing Your Network: Internet Tradecraft, syngress Publishing  
Schneier; Secrets and Lies, John Wiley and Sons, dt. Ausgabe bei DPunkt  
Schneier; Applied Cryptography, John Wiley and Sons, dt. Ausgabe bei Addison Wesley

## Examination

**Method and Duration of Examination:** schriftliche Prüfung 60 min

# Projekt Autonome Systeme

## Modul

<b>Module Name</b>	Projekt Autonome Systeme
<b>Module Level</b>	Bachelor
<b>Credit Points per Module</b>	5
<b>Module Coordinator</b>	Dr. habil. Alfred Schöttl

## General Information about the Course

<b>German Title</b>	Projekt Autonome Systeme
<b>English Title</b>	Project on Autonomous Systems
<b>Code</b>	WF013 – Required Elective Subject
<b>Semester</b>	6/7
<b>Frequency of C. Offer</b>	abhängig vom Bedarf, kein fester Turnus
<b>Credit Points per Course</b>	5
<b>Course Coordinator</b>	Dr. habil. Alfred Schöttl
<b>Hours per Week</b>	4
<b>Teaching Method</b>	project-based course (4 Proj)
<b>Workload</b>	150 Proj = 150 hours
<b>Language</b>	german
<b>Degree Programs</b>	EI/RE/EM
<b>Media</b>	blackboard, flipchart, overhead projector, video projector, e-learning

## Lecturers

Dr. habil. Alfred Schöttl (Modulverantw.), N.N.

## Recommended Requirements

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## Module Objectives and Planned Learning Outcomes

The students intensify the knowledge and skills of the following areas depending on their specific project task:

- they are able to design, implement and test a robotic software application
- they are able to design and construct (simple) mechanical components
- they are able to integrate electronic components, design adaptors and implement drivers
- they are able to analyze technical tasks and design hardware and software specifications
- they are able to utilize appropriate development and simulation tools for their task

The students practice the interdisciplinary communication by the cross-department teams. The independent team work fosters self-responsibility. The students give a presentation at the end of the project in which technical and non-technical aspects, such as logistical or economical constraints as well as work organization, have to be taken into account.

## Contents

Development of components of autonomous robots and related systems. The work is performed in project teams, which are assigned at the beginning of the semester. The tasks have various core topics taken from the area software, electronics hardware/interfaces and mechanics/mechatronics. All topics comprise the aspects planning, design, implementation and test. The results are demonstrated, ideally in a robotic application. Most used or developed robotic systems utilize the robotics framework ROS; the software- or interface-related tasks are therefore a good opportunity to obtain an introduction to ROS. Subsequent tasks are possible.

## Literature

abhängig von der konkreten Projektaufgabe

## Examination

**Method and Duration of Examination:** Modularbeit (50 %) + Präsentation (50 %), gemäß Vorgaben zu Semesterbeginn

# Projekt Elektrische Fahrzeugantriebe

## Modul

<b>Module Name</b>	Projekt Elektrische Fahrzeugantriebe
<b>Module Level</b>	Bachelor
<b>Credit Points per Module</b>	5
<b>Module Coordinator</b>	Dr.-Ing. Christoph M. Hackl

## General Information about the Course

<b>German Title</b>	Projekt Elektrische Fahrzeugantriebe
<b>English Title</b>	Project on Electric Automotive Drives
<b>Code</b>	WF014 – Required Elective Subject
<b>Semester</b>	6/7
<b>Frequency of C. Offer</b>	abhängig vom Bedarf, kein fester Turnus
<b>Credit Points per Course</b>	5
<b>Course Coordinator</b>	Dr.-Ing. Christoph M. Hackl
<b>Hours per Week</b>	4
<b>Teaching Method</b>	project-based course (4 Proj)
<b>Workload</b>	150 Proj = 150 hours
<b>Language</b>	german
<b>Degree Programs</b>	EI/RE/EM
<b>Media</b>	blackboard, flipchart, overhead projector, video projector, e-learning

## Lecturers

Dr.-Ing. Christoph M. Hackl (Modulverantw.), Dr. Herbert Palm, Dr. Dirk Hirschmann, Dr. Oliver Bohlen, Dr. Ulrich Unterhinninghofen

## Recommended Requirements

Fundamentals of Semester 1-4, Project Management

## Module Objectives and Planned Learning Outcomes

The students deepen their knowledge in the field of electrical engineering as well as in the area of project management through the practical application of the knowledge gained in the previous semesters.

Students are able to analyze complex tasks and to design solution strategies based on them. They can derive specific solutions from the solution strategy and implement them independently. They are trained in interdisciplinary communication with students of other faculties. In specialist talks or presentations they can reflect the level of knowledge of their conversational partner or listener and arrange the conversation or the presentation in such a way that the essential aspects of the special topics are comprehensible for all participants.

Depending on the specific task, the students deepen their specialist competencies in a topic in the field of electrical vehicle drives and electromobility (eg design and construction of drive systems, analysis and evaluation of existing solutions).

## Contents

Students collaborate in project teams on different topics in the field of electric drives for vehicles and electric mobility. Various tasks are presented at the beginning of the semester and assigned to the project groups. These tasks belong to university projects for vehicle development (for example, the „Formula Student Electric“, the project „Porsche SE Boxster“ or the „Shell Eco Marathon“) or their environment (e.g. charging stations).

## Literature

- Hybrid-, Batterie- und Brennstoffzellen-Elektrofahrzeuge - Technik, Strukturen und Entwicklungen. Renningen, expert-Verlag, 2007

- Homepage des HM-Teams des Shell-Eco-Marathon: <http://www.hydro2motion.de>
- Homepage des HM-Teams der Formula Student: [www.munichmotorsport.de](http://www.munichmotorsport.de)

## **Examination**

**Method and Duration of Examination:** Modularbeit (50 %) + Präsentation (50 %), gemäß Vorgaben zu Semesterbeginn

# Simulation regenerativer Energiesysteme

## Modul

<b>Module Name</b>	Simulation regenerativer Energiesysteme
<b>Module Level</b>	Bachelor
<b>Credit Points per Module</b>	5
<b>Module Coordinator</b>	Dr. Oliver Mayer

## General Information about the Course

<b>German Title</b>	Simulation regenerativer Energiesysteme
<b>English Title</b>	Simulation of Renewable Energy Systems
<b>Code</b>	WF018 – Required Elective Subject
<b>Semester</b>	6/7
<b>Frequency of C. Offer</b>	abhängig vom Bedarf, kein fester Turnus
<b>Credit Points per Course</b>	5
<b>Course Coordinator</b>	Dr. Oliver Mayer
<b>Hours per Week</b>	4
<b>Teaching Method</b>	Seminaristischer Unterricht mit integriertem lab exercise (3 SU + 1 Pra)
<b>Workload</b>	42 SU + 14 Pra + 94 preparation/post-processing = 150 hours
<b>Language</b>	german
<b>Degree Programs</b>	EI/RE/EM/DS
<b>Media</b>	blackboard, flipchart, overhead projector, video projector, e-learning

## Lecturers

Dr. Oliver Mayer (Modulverantwort.), Dr. Oliver Mayer

## Recommended Requirements

Fundamentals of Semester 1-4

## Module Objectives and Planned Learning Outcomes

Understanding the basics of simulation generally, simulation techniques and simulation models specifically for renewable energy systems, knowledge of the limits of simulations.

Ability to solve complex problems in the field of renewable energy by means of simulation and to interpret and present the results. In small student projects the communication between the students and the competence for the presentation of project results is encouraged.

## Contents

Basics of simulation technology, development of simulation models for renewable energy systems, comparison of simulation methods, methods for renewable energy systems, presentation of various renewable simulation programs with background info for development, projects as workshop (Student project teams run on their own project tasks), presentation and discussion of project results.

## Literature

Volker Quaschnig; Regenerative Energiesysteme; Hanser Verlag

## Examination

**Method and Duration of Examination:** schriftliche Prüfung 90 min (50 %) + Präsentation 20 min (50 %)