COBURG
UNIVERSITY
of applied sciences and arts

# MODULE MANUAL

## Automation and Robotics (B.Eng.)

Valid für Study and examination regulations (SPO) 2025
13-08-2026

# 1. ABBREVATIONS

| | |
|---|---|
| B.Eng. | Bachelor of Engineering |
| ECTS | European Credit Transfer System |
| S | Summer semester |
| SWS | Contact hours per week |
| W | Winter semester |

## 2. PROFILE OF THE BACHELOR´S PROGRAM

The bachelor's program in Automation and Robotics leads to a first academic degree that qualifies graduates for professional employment in the highly sought-after fields of electrical automation and robotics. Graduates are equipped with a broad foundation and practical skills in the field of electrical engineering and possess in-depth knowledge of the tasks and methods of automation and robotics. They can classify subject-specific topics appropriately and analyze problems using field-specific methods. As a defining feature of the program, graduates also emerge with knowledge in the natural sciences, business administration, and management-related knowledge. They can apply these skills and areas of knowledge in a solution-oriented manner to the often-interdisciplinary tasks encountered in their professional careers and quickly familiarize themselves with one of the many fields of application. Through targeted teaching and learning formats, graduates have acquired communicative, cooperative, and intercultural competencies. They demonstrate a forward-looking professional self-image and a sense of responsibility. For non-German-speaking students, the integrated development of advanced German language skills, alongside content and language integrated learning during the main study phase, facilitates scientific work in German and supports a successful transition into professional careers within German companies. Successful completion of the degree program particularly qualifies graduates to take on application-oriented technical roles and initial leadership responsibilities, for example in the field of production facilities, in automotive production, machine tool manufacturers, robot manufacturers, or in image processing. The degree also qualifies graduates for admission to a master's program.

## 3. MODULE STRUCTURE

| Curriculum of the Study Course on Automation and Robotics | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ECTS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 1W | Fundamentals of Mathematics | | | | | Scientific Basics | | | | | Soft Skills and Culture | | | Technical English | | | | | German Basics 1 (Level A1) | | | | | German Basics 2 (Level A2) | | | | | |
| 2S | Technical Mathematics 1 | | | | | Mechanics 1 | | | | | Measurement Technology | | | | | Fundamentals of Electrical Engineering | | | | | Programming (Python) | | | | German Basics 3 (Level B1.1) | | | | |
| 3W | Technical Mathematics 2 | | | | | Mechanics 2 | | | | | Fluid Dynamics | | | | | Business Administration | | | | | Fundamentals in Computer based meas. Technology | | | | Technical German (Level B1.2) | | | | |
| 4S | Technical Mathematics 3 | | | | | Mathematical Applications | | | | | Thermodynamics | | | | | Control Engineering | | | | | Electrical Drives, Power Grids and Safety | | | | German (Level B2.1) | | | | |
| Content Integrated Language learning | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5W | Computermesstechnik (Computer based meas. Technology) | | | | | Softwareentwicklung in der Automatisierungstechnik (Software Development in Automation) | | | | | Robotik (Robotics) | | | | | Signale und Systeme (Signal and Systems) | | | | | Wahlpflichtfach 1 Elective Subject 1 | | | | Einführung in wissenschaftliches Arbeiten Introduction in Scientific writing (Level B2.2) | | | | |
| 6S | Automatisierungstechnik (Factory Automation) | | | | | Motion Control | | | | | Seminar Automatisierungstechnik und Robotik (Seminar Automation and Robotics) | | | | | Industrielle Bildverarbeitung (Industrial Image Processing) | | | | | Wahlpflichtfach 2 Elective Subject 2 | | | | Wissenschaftliche Präsentation und Diskussion Scientific Presentation and Discussion (Level C1.1) | | | | |
| 7W | Industrial Internship (or Inhouse Laboratory Projects) | | | | | | | | | | | | | | | | | | | | | | | | | (Block) Seminars accompanying Internship | | | | |
| 8S | Bachelor Thesis | | | | | | | | | | | | Bachelor Colloquium | | | Engineering Project | | | | | | | | | Elective Subject 3 | | | | |

## 4. RISK ASSESSMENT

Each module description contains a risk assessment in accordance with the Maternity Protection Act (§ 10ff MuschG). It states whether there are any potential risks to the unborn or the breastfed child of a student if she participates in the course. The assessment of the risk potentials is carried out by the module coordinator.

| | |
|---|---|
| Green | compliant, no restrictions |
| Yellow | requires individual assessment |
| Red | participation is not permitted during pregnancy and breastfeeding. |

o *Chart 1: Risk assessment in accordance with the Maternity Protection Act*

For further information and advice please contact the universities family office.

## 5. MODULE DESCRIPTIONS

The following module descriptions are valid for the Study and examination regulations (SPO) 2025. They will be updated before start of the term, if concept, content, or examination have been changed.

# First theoretical Study Phase – Semester 1

## Introduction to Advanced Mathematics (IAM)

(Automation and Robotics, B.Eng., SPO 2025)

| | |
|---|---|
| **Summary** | Higher mathematics includes arithmetic operations and analytical methods that go beyond the school basics. In addition to the number range of rational numbers, the range of real and complex numbers is also used. Special mathematical functions such as powers, roots, logarithms and angle functions are also required. When describing technical and scientific systems, different equations arise which require special solution algorithms depending on the type of possible non-linearity. Finally, the laws and formulas for plane figures and spatial solids as well as an understanding of the Cartesian coordinate system are also part of the foundations of advanced mathematics. |
| **Instructor responsible for module** | Prof. Dr. Alexander Stadler |
| **Lecturer** | Prof. Dr. Alexander Stadler<br>Carlo Höhn (M.Eng.) |
| **Language of instruction and examination** | **Use in other study programs** |
| English | B.Eng. Mechanical Engineering<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics |

| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
|---|---|---|---|
| 1st semester<br>1st theoretical study phase | Compulsory module | One semester | Once a year in winter semester |

| **WORK AND EXAM PERFORMANCE** | |
|---|---|
| **Participation requirements** | None |
| **ECTS-Credits** | 5 ECTS |
| **Factor of calculation towards degree grade** | 0,5 |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 45 hours online lectures<br>▪ 105 hours self-study |
| **Contact hours per week (SWS)** | 4 |
| **Risk assessment for pregnant women and mothers** | Green |

| Type and scope of the course<br>Examination method/ | Examination method/<br>Requirements for the allocation of credit points | Approved examination aids |
|---|---|---|
| Seminar, seminar-based teaching, exercise<br>2 SWS Lectures<br>2 SWS Exercises / Revisions | Written exam (60-90 min.) | |

**CONTENT, METHODS AND RESULTS**

**Course content**

Numbering systems
- Calculating with rational numbers
- Percentages
- Real and complex numbers

Important real-value functions
- Potencies and roots
- Logarithms
- Sine and cosine, tangent

Basic equations
- The Linear and quadratic equation
- Fractional equations
- Root and exponential equations
- Triogonometric equations

Fundamentals of geometry
- Triangle theorems, similar triangles
- Area of plane shapes
- Surface area, body volume
- The Cartesian coordinate system

**Learning outcomes**

After attending this module, students are aware of fundamental mathematical structures and methods. Students are able to understand the basic concepts of linear algebra and geometry, like vectors, and calculus (e.g. real functions, differential and integral calculus) and are able to apply them to basic problems in science and technics.

**Teaching and learning methods**

The module consists of a series of learning lectures. In these lectures, theoretical principles and exercises are presented. For the presentation of results and the illustration of graphics, the programming language Octave (GNU public license) is used. A short introduction is also part of this course.

| Reading list |
| --- |
| ▪ I. N. Bronstein, H. Mühlig, G. Musiol, K. A. Semendjajew, Taschenbuch der Mathematik, Verlag Europa-Lehrmittel, 11. Auflage, 2020, ISBN-10: 3808557923<br>▪ A. M. Haghighi, A. A. Kumar, D. P. Mishev, Higher Mathematics for Science and Engineering, Springer, 1st Edition, 2025, ISBN-10: 9819954339<br>▪ E. Kreyszig, Advanced Engineering Mathematics, International Adaptation, Wiley, 11th Edition, 2025, ISBN-10: 1394319460<br>▪ G. Merzinger, T. Wirth, Repetitorium Höhere Mathematik, Carl Hanser Fachbuchverlag, 7. Auflage, 2024, ISBN-10: 3446482334<br>▪ K. A. Stroud, D. J. Booth, Engineering Mathematics, Bloomsbury Academic, 8th Edition, 2020, ISBN-10: 1352010275 |

# Scientific Basics (SB)

(Automation and Robotics, B.Eng., SPO 2025), B.Eng., SPO 2025)

| | |
|---|---|
| **Summary** | Nature is described with the help of physical quantities. Their properties are observed and analyzed in experiments and relationships between the variables are investigated. An understanding of the structure of matter, its states of aggregation and changes in state and substance is fundamental to the interpretation of physical and chemical processes. In summary, Scientific Basics contains some fundamental features of our physical world view as well as an insight into the field of inorganic chemistry. |
| **Instructor responsible for module** | Prof. Dr. Martin Prechtl |
| **Lecturer** | Prof. Dr. Martin Prechtl<br>Dr. Klaus Horbaschek<br>Christian Wolf |
| **Language of instruction and examination** | **Use in other study programs** |
| English | B.Eng. Mechanical Engineering<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics |

| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
|---|---|---|---|
| 1st semester<br>1st theoretical study phase | Compulsory module | One semester | Once a year in winter semester |

| **WORK AND EXAM PERFORMANCE** | |
|---|---|
| **Participation requirements** | None |
| **ECTS-Credits** | 5 ECTS |
| **Factor of calculation towards degree grade** | 0,5 |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 45 hours online lectures<br>▪ 105 hours self-study |
| **Contact hours per week (SWS)** | 4 |
| **Risk assessment for pregnant women and mothers** | Green<br>The courses pose no risks to pregnant women or mothers. |

| Type and scope of the course<br>Examination method/ | Examination method/<br>Requirements for the allocation of credit points | Approved examination aids |
|---|---|---|
| Seminar, seminar-based teaching, exercise<br>2 SWS Lectures, partially virtual laboratory tour<br>2 SWS Exercise / Revision | 6 short online midterm tests (each 15 min.) and written exam at the end of the semester (60-90 min.) | Basic scientific calculator |
| **CONTENT, METHODS AND RESULTS** | | |

| Course content |
| --- |
| **Physical quantities and their units (Prof. Dr. M. Prechtl)**<br>▪ Types of description of objects and processes<br>▪ The International System of Units<br>▪ Definition of selected physical quantities<br>▪ Physical constants of nature<br>▪ Dealing with very small / large values, prefixes<br>**Basics of experimentation (Lecturer Chr. Wolf)**<br>▪ Planning and conducting experiments<br>▪ Observation and data collection<br>▪ Measurement error and accuracy<br>▪ Evaluation, conclusion and documentation<br>**The Structure of atoms (Prof. Dr. M. Prechtl)**<br>▪ Structure of atomic nuclei und nuclear reactions<br>▪ The Bohr's atomic model energy levels<br>▪Basics of quantum mechanics<br>▪ Atomistic interpretation of physical effects<br>**Chemical and physical bonding (Dr. K. Horbaschek)**<br>▪ Types of chemical bonds: Ionic, metallic and covalent bond<br>▪ Electronegativity and bond polarity<br>▪ Nomenclature of binary compounds<br>▪ The octet rule and its many exceptions<br>▪ Structure of chemical compounds<br>▪ The van der Waals interaction, hydrogen bondEnergetically stable atoms and the octet rule<br>**The states of matter (Dr. K. Horbaschek)**<br>▪ Solids, liquids, gases and plasma state<br>▪ The change of the aggregte state, phase diagrams<br>▪ Mixtures of substances<br>▪ Some selected physical properties of matter<br>**Chemical reactions and stoichiometry (Dr. K. Horbaschek)**<br>▪ Types of chemical reactions, e.g. acid-base, redox, complexation, metathesis<br>▪ Reaction equation, law of conservation of mass<br>▪ Stoichiometry of chemical reactions<br>▪ Exothermic and endothermic reactions<br>▪ Chemical equilibria, e.b. acid base equilibria, solubility product |

| Learning outcomes |
| --- |
| Skills in Fundamentals of Physics:<br>Students understand the basic structure of matter and can use this knowledge to explain simple processes and effects in nature and technology. They are able to de-scribe observations qualitatively and quantitatively. In addition, students can handle small and large values and have a sense of the magnitude of values.<br>Chemical Competencies:<br>Students are able to use chemical nomenclature correctly. They are able to describe basic relationships between structure and chemical and physical properties of chemical compounds. Students are able to solve basic quantitative problems.<br>Execution of Experiments and Documentation:<br>Students will be able to systematically conduct experiments, accurately record measurement data, and document procedures and results in a clear and standardized format.<br>Data Analysis and Interpretation:<br>Students will be able to analyze experimental data using funda-mental statistical methods, quantify uncertainties, and critically evaluate the significance and limitations of their results. |
| **Teaching and learning methods** |
| Flipped classroom:<br>Students study theoretical content (e.g. videos, readings) before class. Live ses-sions are used for discussions, applications, and problem-solving.<br>Concept Checks:<br>Short, targeted questions used during class to assess students' understanding of key concepts and uncover misconceptions.<br>Live polling:<br>Interactive tools are used in real time to collect student responses, visualize results, and stimulate discussion. |
| **Reading list** |
| Literature for physics:<br>▪ W. Dempträder: Nuclear and Particle Physics. Springer Nature Switzerland, 2023<br>▪ G.L. Squires: Practical Physics. Cambridge University Press, 2003<br>▪ J.P.Holman: Experimental methods for Engineers. McGraw-Hill Book, 2001<br>Literature for chemistry:<br>▪ T. Brown: Chemistry - The Central Science in SI Units. Person Education, 2021 |

# Academic English Skills (AES)

(Automation and Robotics, B.Eng., SPO 2025)

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|---|---|
| **Summary** | The "Academic English Skills" module teaches the essential language and methodological skills for everyday academic life. It includes academic writing and reading, the targeted development of a subject-specific vocabulary and the improvement of grammatical and stylistic skills. In addition, oral communication skills, research techniques and critical thinking are trained so that students are optimally prepared for scientific challenges. The targeted language level is at the CEFR B2.2. |
| **Instructor responsible for module** | Barney Craven |
| **Lecturer** | Barney Craven<br>Helen Bulluck |
| **Language of instruction and examination** | **Use in other study programs** |
| English | B.Eng. Automation and Robotics<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics |

| Semester and study phase | Module category | Duration of module | Frequency of module offer |
|---|---|---|---|
| 1st semester<br>1st theoretical study phase | Compulsory module | One semester | Once a year in winter semester |

| **WORK AND EXAM PERFORMANCE** | |
|---|---|
| **Participation requirements** | minimum English language skills at the CEFR B2.1 level |
| **ECTS-Credits** | 5 ECTS |
| **Factor of calculation towards degree grade** | 0,25 |
| **Workload** | Overall workload: 150 hours, comprising:<br>▪ 15 hours online lecture course<br>▪ 45 hours online tutorial course<br>▪ 90 hours self-study |
| **Contact hours per week (SWS)** | 4 |
| **Risk assessment for pregnant women and mothers** | Green |

| Type and scope of the course<br>Examination method/ | Examination method/<br>Requirements for the allocation of credit points | Approved examination aids |
|---|---|---|
| Seminar, seminar-based teaching, exercise<br>Lecture course (1 SWS)<br>Tutorial course (3 SWS) | Written exam (60-90 min.) | None |

**CONTENT, METHODS AND RESULTS**

**Course content**

▪ Cultural awareness: recognition of cultural influences in the professional and academic environments.

▪ Academic and professional writing: techniques for correspondence, research reports and papers, as well as learning citation and referencing systems (e.g., APA, MLA).

▪ Academic reading: strategies for understanding and analysing scientific texts, critical reading and extracting relevant information from specialist literature.

▪ Critical thinking: methods for analyzing, evaluating and synthesizing information in order to develop one's own scientific arguments.

▪ Vocabulary and terminology: development of a subject-specific vocabulary and academic idioms.

▪ Grammar and style: development of grammatical structures and stylistic devices that are common in an academic context.

▪ Oral communication: techniques for holding academic presentations and participating in academic discussions.

▪ Listening comprehension: strategies for understanding lectures, seminars and academic discussions.

**Learning outcomes**

General Competence: Active and passive language skills (speaking, listening comprehension, reading and writing) at the CEFR

2 level or higher

▪ subject-specific focus – technical vocabulary

▪ professional and academic focus – meeting and interviewing skills, presentation techniques, correspondence, reports, academic texts

Methodological competence

▪ Acquisition of learning strategies that enable autonomous learning; certain tasks enable reflection on the strategies used

Intercultural competence

▪ Use of appropriate language (e.g. registers, forms of politeness) in intercultural interactions in professional and social situations

▪ knowledge of English-speaking countries

**Teaching and learning methods**

Synchronous lectures, synchronous interactive work, independent learning, Flipped classroom, problem-based learning, role plays and simulation, peer learning

| Reading list |
| --- |
| Material will be provided in Moodle. |

# Soft Skills and Culture (SKC)

(Automation and Robotics, B.Eng., SPO 2025)

| | | | |
|---|---|---|---|
| **Summary** | Trainings in soft skills and basic knowledge of German culture are essential for integration in local society and working culture. | | |
| **Instructor responsible for module** | 2 SWS | | |
| **Lecturer** | Katja Zimmer, M.A. | | |
| **Language of instruction and examination** | **Use in other study programs** | | |
| English | B.Eng. Mechanical Engineering<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics | | |
| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
| 1st semester<br>1st theoretical study phase | Compulsory module | One semester | Once a year in winter semester |
| **WORK AND EXAM PERFORMANCE** | | | |
| **Participation requirements** | None | | |
| **ECTS-Credits** | 3 ECTS | | |
| **Factor of calculation towards degree grade** | 0,25 | | |
| **Workload** | Overall workload: 90 hours, comprising<br>▪ 20 hours online lecture<br>▪ 40 hours self-study<br>▪ 30 hours attended event (blocked in Coburg and surroundings) | | |
| **Contact hours per week (SWS)** | 2 | | |
| **Risk assessment for pregnant women and mothers** | Green | | |
| **Type and scope of the course Examination method/** | **Examination method/ Requirements for the allocation of credit points** | **Approved examination aids** | |
| Seminar-based teaching, exercise<br>2 SWS | Portfolio | None | |

## CONTENT, METHODS AND RESULTS

### Course content

Historical context from Middle Ages to Germany today:

Focus on German identity in the 21st century which will offer an understanding of German history, politics, culture and society today.

▪ World War II and overview on German history after WW II

▪ The End of the Cold War: A New National Identity?

▪ Aspects of Modern German Life: Reunification and immigration

▪ Contemporary Challenges and Trends, Political system and its main consequences. Cultural awareness and cross-cultural communications: Understanding the German/European mindset, Dealing with cultural differences and raising of culture awareness

▪ culture models, learning traditions, communication styles

▪ working together and the German work culture: intercultural communication in business, risks and opportunities in international teams and special features of intercultural cooperation

Culture shock: Some typical German customs

Studying in Germany:

Understanding German Academic Culture

▪ Learning traditions: how to raise independent learning, conditions for successful learning

Excursions to the Coburg area and its neighbors.

### Learning outcomes

▪ Historical Understanding: Contemporary German Society and Politics: Describe the structure of the German political system; identify contemporary challenges facing Germany, including immigration and social integration.

▪ Cultural Competence and Intercultural Communication: Recognize and interpret cultural differences using established cultural models. Demonstrate an understanding of the German/European mindset and customs, apply intercultural communication skills in academic and professional contexts

▪ Academic Culture and Study Skills:  Understand the structure and expectations of German academic institutions; reflect on your own study style, practice independent learning strategies and adapt to German learning traditions.

▪ Experiential and Local Learning: Engage with German culture and history through excursions in the Coburg area and surrounding regions, reflect on direct experiences to deepen understanding of regional identity and local traditions.

### Teaching and learning methods

Active learning method: critical incidents and role plays, group work;

Experiential learning;

Reflective Journals

Synchronous Online Teaching and Asynchronous Learning

### Reading list

▪ Hofstede, G. (2011). Dimensionalizing Cultures: The Hofstede Model in Context. Online Readings in Psychology and Culture, 2(1). https://doi.org/10.9707/2307-0919.1014

▪ recent articles on Germany’s contemporary situation from different sources

▪ Literature based on participants’ cultural background

# German Basics 1, Level A1 (GB 1)

(Automation and Robotics, B.Eng., SPO 2025)

| | |
|---|---|
| **Summary** | The German Basics 1 (Level 1) course is designed for international students with little or no previous knowledge of German. The aim is to build up basic knowledge that will enable students to participate for the communication in every day and academic scenarios (oral/written) from the start of the programme. The course content is tailored to the needs of the target group (e.g. internship).<br>These are …<br>▪ practice-oriented learning objectives (aligned by typical language/writing activities)<br>▪ Basic vocabulary<br>▪ Written communication: text type specific structures<br>▪ Teaching learning strategies to enable autonomous learning<br>▪ Use of authentic material<br>The focus is on everyday communication in studies and work, (lexis and grammar follow this content (form follows content/function) |
| **Instructor responsible for module** | Dr. Edgar Skvotsov |
| **Lecturer** | Dr. Edgar Skvotsov |
| **Language of instruction and examination** | **Use in other study programs** |
| German and English | B.Eng. Mechanical Engineering<br>B.Eng. Digital Business Models and Technologies<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics |

| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
|---|---|---|---|
| 1st semester<br>1st theoretical study phase | Compulsory module | One semester | Once a year in winter semester |

| **WORK AND EXAM PERFORMANCE** | |
|---|---|
| **Participation requirements** | None |
| **ECTS-Credits** | 5 ECTS |
| **Factor of calculation towards degree grade** | 0,25 |
| **Workload** | Overall workload: 180 hours, comprising 67,5 contact hours and 112,5 hours self-study |
| **Contact hours per week (SWS)** | 6 |

| | | |
|---|---|---|
| **Risk assessment for pregnant women and mothers** | Green | |
| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
| Seminar-based teaching, exercise<br>6 SWS | Written exam (90 min.) | Headphones |

## CONTENT, METHODS AND RESULTS

**Course content**

Students acquire linguistic and cultural competences (reading, listening, writing and speaking skills) for everyday life and study in German. German is usually the second, third or additional language English. It is of central importance for multilingual learners to recognise the language as a system (language comparison). In this way, they develop a deeper understanding of linguistic structures (grammar, lexis) and the cultural context, which improves their ability to communicate independently in everyday life. Students can furthermore use language assistants, apps, online resources and similar tools to manage and expand their language learning.

**Learning outcomes**

Language Proficiency A1

Spoken interaction

▪ Can describe simple aspects of daily life in a sequence of simple sentences, using simple words and elementary phrases where preparation is possible.

▪ Can describe him/herself (name, age, family) usind simple words and formulaic expressions where preparation is possible.

▪ Can name an object (shape/colour) using elementary words and formulaic expressions where preparation is possible.

Reading Comprehension

▪ Can understand short texts on topics of personal interest (e.g. course announcements or stories on sport, music, travel) written in simple words and supported by illustrations and pictures.

▪ Can find and understand simple and important information in advertisements for special events, on handouts and in brochures (e.g. what is on offer, costs and prices, dates and places of events, departure times, etc.).

▪ Can understand short and simple messages (e.g. posts on social media or emails) suggesting when and where to meet.

Written production

▪ Can give information on matters of personal relevance (e.g. likes and dislikes, family, pets) using simple words/signs and elementary expressions.

▪ Can give basic personal information in writing (e.g. name, address, nationality), using the dictionary where appropriate.

▪ Can use very simple words/signs and phrases to describe certain everyday objects (for example, the colour of a car, whether it is big or small).

| Teaching and learning methods |
| --- |
| German Online Training according to the Common European Framework of Reference (CEFR) will enable to move up an entire language level (A1). The training focuses on listening skills, reading and spoken skills. The materials are e.g. audio files, reading texts, videos and cloze exercises. The course is divided into lessons (learning platform Moodle) that teach the vocabulary and grammar to practice basic scenarios in daily life. |
| **Reading list** |
| 1. Council of Europe: Global scale - Table 1 (CEFR 3.3): Common Reference levels (coe.int) Council of Europe: Official translations of the CEFR Global Scale (coe.int) [03.04.25]<br>2. Gemeinsamer Europäischer Referenzrahmen für Sprachen: lernen, lehren, beurteilen. Begleitband. 2020. Stuttgart: Klett, ISBN 978-3-12-676999-0. [03.04.25]<br>3. Glaboniat, M.; Müller, M.;Rusch, P.; Schmitz, Helen; Wertenschlag, L.. 2013. Profile deutsch A1-C2. 1. Aufl.. Lernzielbestimmungen, Kannbeschreibungen, Kommunikative Mittel. Stuttgart: Klett, ISBN 978-3-12-606518-4.<br><br>Learning material:<br>▪ Kurs DaF A1. Deutsch für Studium und Beruf, Kurs- und Übungsbuch. 2023. KLETT: ISBN 978-3-12-676838-2<br>▪ Kurs DaF A1. Deutsch für Studium und Beruf Kurs- und Übungsbuch, 2023. Hybride Ausgabe allango, KLETT: ISBN 978-3-12-676841-2. |

# German Basics 2, Level A2 (GB 2)

(Automation and Robotics, B.Eng., SPO 2025)

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|---|---|
| **Summary** | The German Basics 2 (Level 2) course is designed for international students with elementary German language skills (Level A1). The aim is to enlarge their repertoire of linguistic and cultural competences that will enable students to participate in every day and academic scenarios (oral/written) and to identify and compare core aspects of German culture and society. The course content is tailored to the needs of the target group (e.g. internship).<br>These are ...<br>▪ practice-oriented learning objectives (aligned by typical language/writing activities)<br>▪ Basic vocabulary<br>▪ Written communication: text type specific structures<br>▪ Teaching learning strategies to enable autonomous learning<br>▪ Use of authentic material<br>The focus is on everyday communication in studies and work, (lexis and grammar follow this content (form follows content/function) |
| **Instructor responsible for module** | Dr. Edgar Skvotsov |
| **Lecturer** | Dr. Edgar Skvotsov |
| **Language of instruction and examination** | **Use in other study programs** |
| German and English | B.Eng. Mechanical Engineering<br>B.Eng. Digital Business Models and Technologies<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics |

| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
|---|---|---|---|
| 2st semester<br>1st theoretical study phase | Compulsory module | One semester | Once a year in winter semester |

| **WORK AND EXAM PERFORMANCE** | |
|---|---|
| **Participation requirements** | Students are only permitted to enter the second part of the semester (second stage of study) if they have completed the German Basics 1 (Level A1) modules in accordance with the appendix to the study and examination requirements. |
| **ECTS-Credits** | 7 ECTS |
| **Factor of calculation towards degree grade** | 0,25 |

| | | |
|---|---|---|
| **Workload** | Overall workload: 360 hours, comprising 135 contact hours and 225 hours self-study | |
| **Contact hours per week (SWS)** | 12 | |
| **Risk assessment for pregnant women and mothers** | Green | |
| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
| Seminar-based teaching, exercise<br>12 SWS | Written exam (90 min.) | Headphones |

## CONTENT, METHODS AND RESULTS

**Course content**

Students acquire linguistic and cultural competences (reading, listening, writing and speaking skills) for everyday life and study in German. German is usually the second, third or additional language English. It is of central importance for multilingual learners to recognise the language as a system (language comparison). In this way, they develop a deeper understanding of linguistic structures (grammar, lexis) and the cultural context, which improves their ability to communicate independently in everyday life. Stu-dents can furthermore use language assistants, apps, online resources and similar tools to manage and expand their language learning.

**Learning outcomes**

Language Proficiency A2

Spoken interaction

▪ Can give a short, straightforward presentation on a familiar topic in own field with sufficient clarity to be followed with most effort, explaining the main points with sufficient precision.

▪ Can describe plans and arrangements, habits and daily activities and talk about past activities and personal experiences.

▪ Can report on aspects of own daily life, e.g. people, places, experiences in work and education.

Reading Comprehension

▪ Can understand very simple formal emails and letters (e.g. confirmations of bookings or online purchases) / Can understand short personal letters.

▪ Can find concrete, predictable information in simple everyday texts, e.g. advertisements, leaflets, menus, biblio-graphies and timetables.

▪ Can understand a short factual presentation or report on own field of interest provided it is written in simple language and does not contain unpredictable details.

Written production

▪ Can write in connected sentences about everyday aspects of own environment, such as people, places, a job or study experiences.

▪ Can write a series of simple sentences about own family, personal circumstances, educational background, current or previous occupation.

▪ Can write a very short, elementary description of events, past actions and personal experiences.

| Teaching and learning methods |
| --- |
| German Online Training according to the Common European Framework of Reference (CEFR) will enable to move up an entire language level (A2). The training focuses on listening skills, reading and spoken skills. The materials are e.g. audio files, reading texts, videos and cloze exercises. The course is divided into lessons (learning platform Moodle) that teach the vocabulary and grammar to practice basic scenarios in daily life. |
| **Reading list** |
| 1. Council of Europe: Global scale - Table 1 (CEFR 3.3): Common Reference levels (coe.int) Council of Europe: Official translations of the CEFR Global Scale (coe.int) [03.04.25]<br>2. Gemeinsamer Europäischer Referenzrahmen für Sprachen: lernen, lehren, beurteilen. Begleitband. 2020. Stuttgart: Klett, ISBN 978-3-12-676999-0. [03.04.25]<br>3. Glaboniat, M.; Müller, M.;Rusch, P.; Schmitz, Helen; Wertenschlag, L.. 2013. Profile deutsch A1-C2. 1. Aufl.. Lernzielbestimmungen, Kannbeschreibungen, Kommunikative Mittel. Stuttgart: Klett, ISBN 978-3-12-606518-4.<br><br>Learning material:<br>▪ Kurs DaF A2. Deutsch für Studium und Beruf, Kurs- und Übungsbuch. 2024. KLETT: ISBN 978-3-12-676840-5.<br>▪ Kurs DaF A2. Deutsch für Studium und Beruf Kurs- und Übungsbuch. 2024. Hybride Ausgabe allango, KLETT: ISBN 978-3-12-676840-5. |

# Second theoretical Study Phase – Semester 2 to 4

## Mathematical Applications

(Automation and Robotics, B.Eng., SPO 2025)

| | |
|---|---|
| **Summary** | Based on real-world data and case studies, this course teaches students to apply numerical methods, data analysis, and modeling tech-niques to solve practical engineering problems. Topics include numerical integration, solving differential equations, and large-scale linear systems, supported by Python-based computation. Students explore statistics, data visualization, PCA, and SVD to extract insights from complex datasets, while signal processing tools such as Fourier transforms and filtering techniques are used for analyzing dynamic signals. The course also covers optimization, machine learning fundamentals (classification, regression, clustering), and techniques for physical modeling, Monte Carlo simulation, and stochastic processes. Throughout the course, Python is used to build, simulate, and analyze mathematical models, culminating in a project-based application that integrates theory with practical problem-solving. |
| **Instructor responsible for module** | |
| **Lecturer** | |
| **Language of instruction and examination** | **Use in other study programs** |
| English | B.Eng. Mechanical Engineering<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics |

| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
|---|---|---|---|
| 4th semester<br>3rd theoretical study phase | Compulsory module | One semester | Once a year in summer semester |

| **WORK AND EXAM PERFORMANCE** | |
|---|---|
| **Participation requirements** | |
| **ECTS-Credits** | 5 ECTS |
| **Factor of calculation towards degree grade** | 2 |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 45 contact hours<br>▪ 105 hours self-study |
| **Contact hours per week (SWS)** | 4 |

| | | |
|---|---|---|
| **Risk assessment for pregnant women and mothers** | Green | |
| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
| Seminar-based teaching, exercise<br>4 SWS | Practical course project (lab report, survey, project, or field report) | |

## CONTENT, METHODS AND RESULTS

**Course content**

Numerical Methods for
- Integration
- Solving Differential Equations (PDE, ODE)
- Solving Large-Scale Linear Systems

Statistics and Data Analysis
- Data Visualization
- PCA
- SVD

Signal Processing
- Fourier Transforms (DFT, FFT)
- FIR and IIR Filters
- Spectral Analysis

Optimization and Machine Learning
- Linear and Nonlinear Optimization
- Gradient-Based Methods
- Introduction to Machine Learning: Classification, Regression, Clustering

Modelling and Simulation
- Physical Modelling with Differential Equations
- Monte Carlo Methods
- Stochastic Simulations and Random Processes

| Learning outcomes |
| --- |
| Numerical Methods for<br>▪ Integration<br>▪ Solving Differential Equations (PDE, ODE)<br>▪ Solving Large-Scale Linear Systems<br><br>Statistics and Data Analysis<br>▪ Data Visualization<br>▪ PCA<br>▪ SVD<br><br>Signal Processing<br>▪ Fourier Transforms (DFT, FFT)<br>▪ FIR and IIR Filters<br>▪ Spectral Analysis<br><br>Optimization and Machine Learning<br>▪ Linear and Nonlinear Optimization<br>▪ Gradient-Based Methods<br>▪ Introduction to Machine Learning: Classification, Regression, Clustering<br><br>Modeling and Simulation<br>▪ Physical Modeling with Differential Equations<br>▪ Monte Carlo Methods<br>▪ Stochastic Simulations and Random Processes |
| **Teaching and learning methods** |
| |
| **Reading list** |
| |

# German Basics 3, Level B1.1 (GB3)

(Automation and Robotics, B.Eng., SPO 2025)

| | |
|---|---|
| **Summary** | The German Basics 3 (Level B1.1) course is designed for international students with basic German language skills (Level A2). The aim is to enlarge the repertoire of linguistic and cultural competences and to enable students to acquire study and work-related topics in oral and written communication, to be aware of cultural differences between their country of origin and Germany and to interact flexibly with culturally influenced forms of behaviour. The course content is tailored to the needs of the target group (e.g. internship). These are …<br>▪ practice-oriented learning objectives (aligned by typical language/writing activities)<br>▪ Basic vocabulary<br>▪ Written communication: text type specific structures<br>▪ Teaching learning strategies to enable autonomous learning<br>▪ Use of authentic material<br>The focus is on everyday communication in studies and work, (lexis and grammar follow this content (form follows content/function) |
| **Instructor responsible for module** | Dr. Edgar Skvotsov |
| **Lecturer** | Dr. Edgar Skvotsov |
| **Language of instruction and examination** | **Use in other study programs** |
| German and English | B.Eng. Engineering Physics (EP)<br>B.Eng. Mechannical Engineering (ME)<br>B.Eng. Digital Business Models and Technologies<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy |

| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
|---|---|---|---|
| 5nd semester<br>2nd theoretical study phase | Compulsory module | One semester | Once a year in summer semester |

| **WORK AND EXAM PERFORMANCE** | |
|---|---|
| **Participation requirements** | |
| **ECTS-Credits** | 5 ECTS |
| **Factor of calculation towards degree grade** | 0,5 |

| | | |
|---|---|---|
| **Workload** | Overall workload: 120 hours, comprising<br>▪ 45 contact hours<br>▪ 75 hours self-study | |
| **Contact hours per week (SWS)** | 4 | |
| **Risk assessment for pregnant women and mothers** | Green | |
| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
| Seminar-based teaching, exercise<br>4 SWS | Written exam (90-120 min.) | Notebook, Tablet, Headphones |
| **CONTENT, METHODS AND RESULTS** | | |

**Course content**

Students acquire linguistic and cultural competences (reading, listening, writing and speaking skills) for everyday life and study in German. German is usually the second, third or additional language English. It is of central importance for multilingual learners to recognise the language as a system (language comparison). In this way, they develop a deeper understanding of linguistic structures (grammar, lexis) and the cultural context, which improves their ability to communicate independently in everyday life. Stu-dents can furthermore use language assistants, apps, online resources and similar tools to manage and expand their language learning.

Language Proficiency B1.1

Spoken interaction

▪ Can give straightforward descriptions or reports on a range of familiar topics in own field of interest

▪ Can give short reasons or explanations for views, plans or actions.

▪ Can give a prepared, straightforward presentation on a familiar topic in own field in such a way that it can usually be followed with ease, explaining the main points with sufficient precision.

Reading Comprehension

▪ Can understand short texts on topics of personal interest (e.g. course announcements or stories on sport, music, travel) written in simple words and supported by illustrations and pictures.

▪ Can understand short and simple messages (e.g. posts on social media or emails) suggesting when and where to meet.

▪ Can read uncomplicated non-fiction texts on topics related to own interests and areas of expertise with pacifying understanding.

Written production

▪ Can produce straightforward, coherent text on a range of familiar topics within his/her field of interest, linking individual shorter passages in a linear sequence.

▪ Can write a very short, elementary description of events, past actions and personal experiences

▪ Can summarise, report and comment with some confidence on a wide range of factual information in his/her field, both on familiar routine matters and on less routine matters.

References:

1. Council of Europe: Global scale - Table 1 (CEFR 3.3): Common Reference levels (coe.int) Council of Europe: Official translations of the CEFR Global Scale (coe.int) [03.04.25]

2. Gemeinsamer Europäischer Referenzrahmen für Sprachen: lernen, lehren, beurteilen. Begleitband. 2020. Stuttgart: Klett, ISBN 978-3-12-676999-0. [03.04.25]

3. Glaboniat, M.; Müller, M.;Rusch, P.; Schmitz, Helen; Wertenschlag, L.. 2013. Profile deutsch. 1. Aufl.. Lernzielbestimmungen, Kannbeschreibungen, Kommunikative Mittel. Stuttgart: Klett, ISBN 978-3-12-606518-4.

**Learning outcomes**

Students acquire linguistic and cultural competences (reading, listening, writing and speaking skills) for everyday life and study in German. German is usually the second, third or additional language English. It is of central importance for multilingual learners to recognise the language as a system (language comparison). In this way, they develop a deeper understanding of linguistic structures (grammar, lexis) and the cultural context, which improves their ability to communicate independently in everyday life. Students can furthermore use language assistants, apps, online resources and similar tools to manage and expand their language learning.

| Teaching and learning methods |
| --- |
| |
| **Reading list** |
| ▪ Kurs DaF B1. Deutsch für Studium und Beruf, Kurs- und Übungsbuch. 2025. KLETT: ISBN 978-3-12-676842-9.<br>▪ Kurs DaF B1. Deutsch für Studium und Beruf Kurs- und Übungsbuch. 2024. Hybride Ausgabe allango, KLETT.<br>Subject-specific learning materials will be provided in the course. |

# Technical German 1, Level B1.2 (TG 1)

(Automation and Robotics, B.Eng., SPO 2025)

| | |
|---|---|
| **Summary** | The Technical German (Level B1.2) course is designed for international students with independent German language skills (Level B1.1). The aim is to enlarge the repertoire of linguistic and cultural competences and to enable students to acquire study and work-related topics in oral and written communication, to be aware of cultural differences between their country of origin and Germany and to interact flexibly with culturally influenced forms of behaviour. The course content is tailored to the needs of the target group (e.g. internship). These are …<br>▪ practice-oriented learning objectives (aligned by typical language/writing activities)<br>▪ Basic vocabulary<br>▪ Written communication: text type specific structures<br>▪ Teaching learning strategies to enable autonomous learning<br>▪ Use of authentic material<br>The focus is on everyday communication in studies and work, (lexis and grammar follow this content (form follows content/function) |
| **Instructor responsible for module** | Dr. Edgar Skvorcov |
| **Lecturer** | Dr. Edgar Skvorcov |
| **Language of instruction and examination** | **Use in other study programs** |
| German | B.Eng. Mechanical Engineering<br>B.Eng. Digital Business Models and Technologies<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics |

| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
|---|---|---|---|
| 3rd semester<br>2nd theoretical study phase | Compulsory module | One semester | Once a year in winter semester |

| **WORK AND EXAM PERFORMANCE** | |
|---|---|
| **Participation requirements** | - |
| **ECTS-Credits** | 5 ECTS |
| **Factor of calculation towards degree grade** | 0,5 |
| **Workload** | |
| **Contact hours per week (SWS)** | 4 |

| | | |
|---|---|---|
| **Risk assessment for pregnant women and mothers** | Green | |
| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
| Seminar-based teaching, exercise<br>4 SWS | Written exam (90-120 min.) | |

## CONTENT, METHODS AND RESULTS

**Course content**

Students acquire linguistic and cultural competences (reading, listening, writing and speaking skills) for everyday life and study in German. German is usually the second, third or additional language English. It is of central importance for multilingual learners to recognise the language as a system (language comparison). In this way, they develop a deeper understanding of linguistic structures (grammar, lexis) and the cultural context, which improves their ability to communicate independently in everyday life.

References:

1. Council of Europe: Global scale - Table 1 (CEFR 3.3): Common Reference levels (coe.int) Council of Europe: Official translations of the CEFR Global Scale (coe.int) [03.04.25]

2. Gemeinsamer Europäischer Referenzrahmen für Sprachen: lernen, lehren, beurteilen. Begleitband. 2020. Stuttgart: Klett, ISBN 978-3-12-676999-0. [03.04.25]

3. Glaboniat, M.; Müller, M.;Rusch, P.; Schmitz, Helen; Wertenschlag, L.. 2013. Profile deutsch. 1. Aufl.. Lernzielbestimmungen, Kannbeschreibungen, Kommunikative Mittel. Stuttgart: Klett, ISBN 978-3-12-606518-4.

# Technical German 2, Level B1.2 (TG 1)

| | | | |
|---|---|---|---|
| **Summary** | | | |
| **Instructor responsible for module** | Dr. Edgar Skvorcov | | |
| **Lecturer** | Dr. Edgar Skvorcov | | |
| **Language of instruction and examination** | **Use in other study programs** | | |
| German | B.Eng. Mechanical Engineering<br>B.Eng. Digital Business Models and Technologies<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics | | |
| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
| 3rd semester<br>2nd theoretical study phase | Compulsory module | One semester | Once a year in winter semester |
| **WORK AND EXAM PERFORMANCE** | | | |
| **Participation requirements** | | | |
| **ECTS-Credits** | | | |
| **Factor of calculation towards degree grade** | | | |
| **Workload** | | | |
| **Contact hours per week (SWS)** | | | |
| **Risk assessment for pregnant women and mothers** | Green | | |
| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** | |
| Seminar-based teaching, exercise<br>4 SWS | Written exam (90-120 min.) | | |
| **CONTENT, METHODS AND RESULTS** | | | |
| **Course content** | | | |
| | | | |

| Learning outcomes |
| --- |
| |
| **Teaching and learning methods** |
| |
| **Reading list** |
| |

# Fundamentals in Computer-based Measurement Technology

(Automation and Robotics, B.Eng., SPO 2025)

| | |
|---|---|
| **Summary** | Students will understand the fundamental principles of measurement technology, including sensor types, measurement chains, and the detection of mechanical, thermodynamic, electromagnetic, and optical quantities. They will be able to condition and digitize signals through amplification, range adjustment, sampling, and the use of DACs and ADCs, while also applying concepts such as number systems, sampling theorem, and windowing. They will gain competence in data communication interfaces such as RS-232, USB, GPIB, VISA, and SCPI, as well as in digital data processing using filters and the DFT. In the laboratory, they will learn to build measurement circuits on a breadboard, apply operational amplifiers, measure voltages, currents, and resistances, and work with microcontrollers using MicroPython. By the end, they will be capable of designing and implementing a complete digital measurement system, including sensor acquisition, analogue frontends, high-resolution ADCs, PC communication, and GUI-based data evaluation. |
| **Instructor responsible for module** | Prof. Dr. Conrad Wolf |
| **Lecturer** | Prof. Dr. Conrad Wolf |
| **Language of instruction and examination** | **Use in other study programs** |
| English | B.Eng. Mechanical Engineering<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy |

| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
|---|---|---|---|
| 3rd semester<br>2nd theoretical study phase | Compulsory module | One semester | Once a year in winter semester |

| **WORK AND EXAM PERFORMANCE** | |
|---|---|
| **Participation requirements** | |
| **ECTS-Credits** | 5 ECTS |
| **Factor of calculation towards degree grade** | 2 |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 60 contact hours<br>▪ 90 hours self-study |
| **Contact hours per week (SWS)** | 4 |

| | | |
|---|---|---|
| **Risk assessment for pregnant women and mothers** | Green | |
| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
| Seminar-based teaching, exercise, internship<br>4 SWS | Written exam (90-120 min.) | |

## CONTENT, METHODS AND RESULTS

**Course content**

**Lecture:**

- **Introduction**
  Fundamentals of measurement technology, mechanical, electronic, and computer-based measurement, measurement chain
- **Sensors**
  Detection of mechanical, thermodynamic, electromagnetic, and optical quantities
- **Signal Conditioning**
  Conversion of measurement signals into voltage, amplification, adjustment of the measurement range
- **Data Acquisition**
  Number systems in computing, sample & hold, DAC, ADC, measuring instruments, sampling theorem, windowing
- **Interfaces & Protocols**
  Communication model, network topologies, RS-232, USB, GPIB, VISA, SCPI
- **Data Processing**
  Digital filters, DFT

**Lab:**

The lab is based on individual experiment kits per student consisting of a prototype breadboard and a Raspberry Pi Pico microcontroller. The following topics are covered:

- **Project Introduction**
  First MicroPython script, measurement with a photodiode
- **Measurement of Small Voltages**
  Operational amplifiers, assembly of inverting and differential amplifiers, measurement of a thermocouple
- **Measurement of Currents**
  Shunt resistor, transimpedance amplifier, measurement of a photodiode
- **Measurement of Resistances**
  Building a Wheatstone bridge with an instrumentation amplifier, RTD, measurement of a strain gauge
- **Building a Multimeter**
  Connecting an external 16-bit ADC, analog frontend for measuring voltage and current, MicroPython script with command interpreter for communication with a PC, Python GUI

| Learning outcomes |
| --- |
| Measurement technology constitutes an essential foundation for executing physical experiments and enabling technological advancement, with contemporary practice relying predominantly on digital data acquisition and computer-based processing. Within this module, students will become familiar with common sensor technologies and learn to condition their signals through suitable measurement circuits to ensure compatibility with an analogue-to-digital converter. They acquire the ability to transfer measurement data to a PC and perform systematic evaluation using appropriate software tools. In the laboratory component, students can independently construct measurement circuits on a breadboard, interface various sensors with a microcontroller, and implement corresponding measurement routines. Through this integrated theoretical and practical approach, they can understand digital measurement systems and their application in experimental and technological contexts. |
| **Teaching and learning methods** |
| |
| **Reading list** |
| |

# Technical Mathematics 1 (TMA1)

(Automation and Robotics, B.Eng., SPO 2025)

| | | | |
|---|---|---|---|
| **Summary** | This course covers foundational tools needed to describe and analyze real-world engineering systems. Starting with set theory and complex numbers, the course builds toward understanding limits, calculus, and algebraic equations, all of which are essential for modeling change and solving dynamic problems. Topics like matrices, vector spaces, and linear systems allow for the structured analysis of multi-dimensional systems, forming the mathematical core for future studies in mechanics, control systems, and applied physics. | | |
| **Instructor responsible for module** | | | |
| **Lecturer** | Prof. Dr. Ada Bäumner<br>Prof. Dr. Roman Rischke | | |
| **Language of instruction and examination** | **Use in other study programs** | | |
| English | B.Eng. Mechanical Engineering<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics | | |
| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
| 2nd semester<br>2nd theoretical study phase | Compulsory module | One semester | Once a year in summer semester |
| **WORK AND EXAM PERFORMANCE** | | | |
| **Participation requirements** | | | |
| **ECTS-Credits** | 5 ECTS | | |
| **Factor of calculation towards degree grade** | 2 | | |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 67.5 contact hours<br>▪ 82.5 hours self-study | | |
| **Contact hours per week (SWS)** | 6 | | |
| **Risk assessment for pregnant women and mothers** | Green | | |

| Type and scope of the course<br>Examination method/ | Examination method/<br>Requirements for the allocation of credit points | Approved examination aids |
|---|---|---|
| Seminar-based teaching, exercise<br>6 SWS | Written exam (90-120 min.) | |

| CONTENT, METHODS AND RESULTS |
|---|
| **Course content** |
| ▪ Set Theory<br>▪ Fundamentals of Complex Numbers<br>▪ Limits, Sequences, and Series<br>▪ Differential and Integral Calculus of Univariate Real-Valued Functions<br>▪ Matrices and Determinants<br>▪ Vector Spaces<br>▪ Linear Systems of Equations<br>▪ Algebraic Equations (up to Third Order) |
| **Learning outcomes** |
| The student is able to apply fundamental concepts of set theory, complex numbers, matrices, determinants, and vector spaces to analyze and solve mathematical problems. He can compute and interpret limits, sequences, series, derivatives, and integrals of univariate real-valued functions, using calculus techniques to model and solve quantitative problems. He is capable of solving linear systems of equations and algebraic equations up to third order, while demonstrating logical reasoning and mathematical rigor in problem-solving. |
| **Teaching and learning methods** |
| |
| **Reading list** |
| |

# Technical Mathematics 2 (TMA 2)

(Automation and Robotics, B.Eng., SPO 2025)

| | | | |
|---|---|---|---|
| **Summary** | This course focuses on mathematical methods used to model and solve time-dependent and spatially varying systems in engineering. It begins with ordinary differential equations, both first-order and higher-order, which describe dynamic processes such as motion, growth, and decay. Systems of differential equations extend these ideas to coupled phenomena. With vector calculus, including multiple integrals and total differentials, students learn to analyze fields and spatial variations, which are essential in fluid dynamics, thermodynamics, and electromagnetics. The course also introduces partial differential equations for modeling wave motion, heat flow, and other distributed systems, along with numerical integration methods to approximate solutions where analytical ones are difficult or impossible. These tools are crucial for translating physical laws into solvable mathematical models in engineering and applied sciences. | | |
| **Instructor responsible for module** | | | |
| **Lecturer** | | | |
| **Language of instruction and examination** | **Use in other study programs** | | |
| English | B.Eng. Mechanical Engineering<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics | | |
| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
| 3rd semester<br>2nd theoretical study phase | Compulsory module | One semester | Once a year in winter semester |
| **WORK AND EXAM PERFORMANCE** | | | |
| **Participation requirements** | | | |
| **ECTS-Credits** | 5 ECTS | | |
| **Factor of calculation towards degree grade** | 2 | | |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 67.5 contact hours<br>▪ 82.5 hours self-study | | |
| **Contact hours per week (SWS)** | 6 | | |

| | | |
|---|---|---|
| **Risk assessment for pregnant women and mothers** | Green | |
| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
| Seminar-based teaching, exercise<br>6 SWS | Written exam (90-120 min.) | |
| **CONTENT, METHODS AND RESULTS** | | |
| **Course content** | | |
| Vector Calculus<br>▪ Force and moment equilibrium at a point, in rigid bodies, and in systems of rigid bodies<br>▪ Internal section forces<br>▪ Mechanical material properties / tensile test<br>▪ Strains<br>▪ Stresses / strength hypotheses | | |
| **Learning outcomes** | | |
| ▪ First-Order Ordinary Differential Equations<br>▪ Higher-Order Linear Ordinary Differential Equations<br>▪ Vector Calculus (Multiple Integrals, Total Differential)<br>▪ Partial Differential Equations<br>▪ Systems of Linear Differential Equations<br>▪ Fundamentals of Numerical Integration | | |
| **Teaching and learning methods** | | |
| | | |
| **Reading list** | | |
| | | |

# Technical Mathematics 3 (TMA 3)

(Automation and Robotics, B.Eng., SPO 2025)

| | | | |
|---|---|---|---|
| **Summary** | This course equips students with essential mathematical techniques for modelling and analysing complex engineering systems. | | |
| **Instructor responsible for module** | | | |
| **Lecturer** | | | |
| **Language of instruction and examination** | **Use in other study programs** | | |
| English | B.Eng. Mechanical Engineering<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics | | |
| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
| 4th semester<br>2nd theoretical study phase | Compulsory module | One semester | Once a year in summer semester |
| **WORK AND EXAM PERFORMANCE** | | | |
| **Participation requirements** | | | |
| **ECTS-Credits** | 5 ECTS | | |
| **Factor of calculation towards degree grade** | 2 | | |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 67.5 contact hours<br>▪ 82.5 hours self-study | | |
| **Contact hours per week (SWS)** | 4 | | |
| **Risk assessment for pregnant women and mothers** | Green | | |
| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** | |
| Seminar-based teaching, exercise<br>6 SWS | Written exam (90-120 min.) | | |

## CONTENT, METHODS AND RESULTS

### Course content

- Laplace Transform
- Fourier Series & Transform
- Discrete Fourier Transform
- Z-Transform
- Advanced Topics in Mathematics
    - Line Integrals, Multiple Integrals, Surface Integrals
    - Integral Theorems
    - Partial Differential Equations

Systems of Linear Differential Equations

### Learning outcomes

This course provides key mathematical tools for modeling and analyzing engineering systems, emphasizing transformations and advanced calculus. Topics include Laplace and Fourier methods for signal analysis, discrete and Z-transforms for digital systems, and advanced integration and differential equations for multi-dimensional and dynamic problems. These foundations support applications in control systems, physics, and computational engineering.

### Teaching and learning methods

### Reading list

# Mechanics 1 (MEC1)

(Automation and Robotics, B.Eng., SPO 2025)

| | |
|---|---|
| **Summary** | ▪ Students can reproduce the fundamentals of static equilibrium in rigid bodies.<br>▪ Students can construct free-body diagrams of rigid bodies in both plane and space.<br>▪ Students develop solution strategies for determining support and joint reactions, as well as for calculating internal forces in rigid bodies and systems of rigid bodies.<br>▪ Students can determine the internal section forces of rods, torsion bars, and bending beams.<br>▪ Students can calculate the stress states of rods, torsion bars regarding statically indeterminate problems.<br>▪ Students can explain component stresses, principal stresses, and equivalent stresses (Maximum Principal Stress Theory (MPST), Maximum Shear Stress Theory (MSST) and Maximum Distortion Energy Theory (MDET)).<br>▪ Students can characterize materials and develop the necessary procedure for a static strength verification. |
| **Instructor responsible for module** | Carlo Höhn (M.Eng.) |
| **Lecturer** | Carlo Höhn (M.Eng.) |
| **Language of instruction and examination** | **Use in other study programs** |
| English | B.Eng. Mechanical Engineering<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics |

| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
|---|---|---|---|
| 2nd semester<br>2nd theoretical study phase | Compulsory module | One semester | Once a year in summer semester |

| **WORK AND EXAM PERFORMANCE** | |
|---|---|
| **Participation requirements** | |
| **ECTS-Credits** | 5 ECTS |
| **Factor of calculation towards degree grade** | 2 |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 45 hours lectures<br>▪ 105 hours self-study, including 11 hours guided exercise |

| | | |
|---|---|---|
| **Contact hours per week (SWS)** | 4 | |
| **Risk assessment for pregnant women and mothers** | Green | |
| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
| Seminar-based teaching, exercise<br>4 SWS | Written exam (90-120 min.) | |

**CONTENT, METHODS AND RESULTS**

**Course content**

- Vector Calculus
- Force and moment equilibrium at a point, in rigid bodies, and in systems of rigid bodies
- Internal section forces
- Mechanical material properties / tensile test
- Strains
- Stresses / strength hypotheses

**Learning outcomes**

- Students can reproduce the fundamentals of static equilibrium in rigid bodies.
- Students can construct free-body diagrams of rigid bodies in both plane and space.
- Students develop solution strategies for determining support and joint reactions, as well as for calculating internal forces in rigid bodies and systems of rigid bodies.
- Students can determine the internal section forces of rods, torsion bars, and bending beams.
- Students can calculate the stress states of rods, torsion bars regarding statically indeterminate problems.
- Students can explain component stresses, principal stresses, and equivalent stresses (Maximum Principal Stress Theory (MPST), Maximum Shear Stress Theory (MSST) and Maximum Distortion Energy Theory (MDET).
- Students can characterize materials and develop the necessary procedure for a static strength verification.

**Teaching and learning methods**

**Reading list**

# Mechanics 2 (MEC2)

(Automation and Robotics, B.Eng., SPO 2025)

| | | | |
|---|---|---|---|
| **Summary** | Almost all classical machines have systems with moving components, which are typically modeled as mass points or rigid bodies. The mathematical description of motion processes is carried out using vectors in Cartesian or polar coordinates, for example. Newton's second axiom is used to analyze the effect of forces. The solution of the equation of motion formulated in this way, which is a differential equation for the position coordinate of the corresponding body, provides information about the temporal and spatial properties of a mechanical system. Finally, the methods based on Newton's second axiom can also be used to calculate special motion processes such as oscillations or impact processes. | | |
| **Instructor responsible for module** | | | |
| **Lecturer** | | | |
| **Language of instruction and examination** | **Use in other study programs** | | |
| English | B.Eng. Mechanical Engineering<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics | | |
| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
| 3rd semester<br>2nd theoretical study phase | Compulsory module | One semester | Once a year in winter semester |
| **WORK AND EXAM PERFORMANCE** | | | |
| **Participation requirements** | | | |
| **ECTS-Credits** | 5 ECTS | | |
| **Factor of calculation towards degree grade** | 2 | | |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 45 hours lectures<br>▪ 105 hours self-study | | |
| **Contact hours per week (SWS)** | 4 | | |
| **Risk assessment for pregnant women and mothers** | Green | | |

| Type and scope of the course<br>Examination method/ | Examination method/<br>Requirements for the allocation of credit points | Approved examination aids |
|---|---|---|
| Seminar-based teaching, exercise<br>4 SWS | Written exam (90-120 min.) | |

**CONTENT, METHODS AND RESULTS**

**Course content**

**Fundamentals of kinematics**

Mathematical description of the movement of bodies

- Definition of velovity and acceleration
- Cartesian and polar Coordinates
- Linear and circular kinematics of the point
- Planar movements of rigid bodies
- Momentary pole, ideal rolling processes

**Kinetics of the mass point**

Analysis of motion processes with the mass point model

- The basic dynamic equation (second Newton's axiom)
- Free and guided movements with and without resistance forces
- Introduction to one-dimensional oscillations
- Momentum theorem and straight, central impact processes

**Kinetics of the rigid body**

Analysis of plane movements of rigid bodies

- Rotation around fixed axes
- Definition of angular momentum
- Torque set, the moment of inertia and Steiner's theorem
- The general plane movement, rolling processes

**Definition of Work, Energy, Power**

Meaning and simple formulas of these physical quantities

**Learning outcomes**

Students describe the motion of bodies mathematically, defining velocity and acceleration in Cartesian and polar coordinates for linear, circular, and planar movements. They gain the ability to analyse motion using the mass-point model, applying Newton’s second law, studying free and guided motions, and understanding oscillations and impact processes. They analyse rigid-body motion, including rotation about fixed axes, angular momentum, torque, moment of inertia, and rolling processes. They develop a clear understanding of planar rigid-body movements through concepts such as the momentary pole and ideal rolling. Finally, they define basic formulas for work, energy, and power, enabling them to evaluate mechanical systems in practical engineering contexts.

**Teaching and learning methods**

| Reading list |
| --- |
| |

# Fluid Mechanics

(Automation and Robotics, B.Eng., SPO 2025)

| | |
|---|---|
| **Summary** | This introductory course in fluid mechanics covers the fundamental principles governing fluid behavior in engineering systems. Students will learn to analyze hydrostatic forces, apply the continuity and energy equations to pipe flows, and use the momentum conservation theorem to calculate forces and moments in fluid systems. The course also introduces key concepts of fluid kinematics, viscous flows, and distinguishes between laminar and turbulent regimes. Basic heat transfer by conduction is included to provide a foundation for thermal-fluid applications. Emphasis is placed on developing problem-solving skills for real-world engineering scenarios involving incompressible flow and heat transfer in pipes and other systems. |
| **Instructor responsible for module** | |
| **Lecturer** | |
| **Language of instruction and examination** | **Use in other study programs** |
| English | B.Eng. Mechanical Engineering<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics |

| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
|---|---|---|---|
| 3th semester<br>3rd theoretical study phase | Compulsory module | One semester | Once a year in winter semester |

| **WORK AND EXAM PERFORMANCE** | |
|---|---|
| **Participation requirements** | |
| **ECTS-Credits** | 5 ECTS |
| **Factor of calculation towards degree grade** | 2 |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 45 hours lectures<br>▪ 105 hours self-study |
| **Contact hours per week (SWS)** | 4 |
| **Risk assessment for pregnant women and mothers** | Green |

| Type and scope of the course<br>Examination method/ | Examination method/<br>Requirements for the allocation of credit points | Approved examination aids |
|---|---|---|
| Seminar-based teaching, exercise<br>4 SWS | Written exam (90-120 min.) | |

**CONTENT, METHODS AND RESULTS**

**Course content**

Students will be able to:

**Analyze hydrostatic systems:**

- Calculate pressure, determine forces and moments

**Apply core fluid mechanics equations:**

- One-dimensional continuity equation for pipe flows
- Steady and unsteady energy equation (Bernoulli equation)
- Momentum conservation theorem to calculate forces and moments in pipe systems

**Evaluate thermal systems:**

- Calculate heat transfer by conduction in simple configurations

Students will understand:

**Fundamental fluid mechanics concepts:**

- Basic principles and hydrostatics
- Fluid kinematics
- Incompressible flows and streamline theory

**Governing equations:**

- Continuity equation, Energy equation (Bernoulli), Momentum conservation theorem

**Flow behavior:**

- Fundamentals of viscous flows
- Characteristics of laminar and turbulent flows
- Pipe flow dynamics

**Heat transfer:**

- Basic conduction processes

**Learning outcomes**

Students analyse hydrostatic systems by calculating pressure, forces, and moments using core principles such as the continuity equation, Bernoulli's energy equation, and the momentum conservation theorem. They apply these equations to pipe flows—both steady and unsteady—and to determine how forces act within fluid systems. Students also develop skills in evaluating thermal systems, including calculating heat transfer by conduction in simple geometries using basic conduction processes. They build a conceptual foundation in fluid mechanics, covering hydrostatics, fluid kinematics, incompressible flow behaviour, and the differences between laminar and turbulent regimes. Finally, they understand governing equations and flow dynamics well enough to analyse pipe flows and apply momentum, energy, and continuity principles confidently in engineering contexts.

**Teaching and learning methods**

| Reading list |
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| |

# Thermodynamics

(Automation and Robotics, B.Eng., SPO 2025)

| | | | |
|---|---|---|---|
| **Summary** | This course provides a foundational introduction to engineering thermodynamics, focusing on the principles governing energy, heat, and work in mechanical systems. Students will learn to distinguish between system states and processes, analyze phase diagrams, and apply thermodynamic laws to both closed and open systems. Key topics include the behavior of ideal gases and gas mixtures, moist air, and steam; the first and second laws of thermodynamics; and the analysis of cyclic pro-cesses in power-adding and power extracting machines. The course also introduces selected adiabatic flow processes relevant to real-world engineering applications. | | |
| **Instructor responsible for module** | | | |
| **Lecturer** | | | |
| **Language of instruction and examination** | **Use in other study programs** | | |
| English | B.Eng. Mechanical Engineering<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics | | |
| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
| 4th semester<br>3rd theoretical study phase | Compulsory module | One semester | Once a year in summer semester |
| **WORK AND EXAM PERFORMANCE** | | | |
| **Participation requirements** | | | |
| **ECTS-Credits** | 5 ECTS | | |
| **Factor of calculation towards degree grade** | 2 | | |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 45 hours lectures<br>▪ 105 hours self-study | | |
| **Contact hours per week (SWS)** | 4 | | |
| **Risk assessment for pregnant women and mothers** | | | |

| Type and scope of the course<br>Examination method/ | Examination method/<br>Requirements for the allocation of credit points | Approved examination aids |
|---|---|---|
| Seminar-based teaching, exercise<br>4 SWS | Written exam (90-120 min.) | |

**CONTENT, METHODS AND RESULTS**

**Course content**

Students will be able to:

**Distinguish between:**

- State variables
- Process variables

**Calculate:**

- Specific gas constants
- State variables in the two-phase region
- Properties of ideal gases and gas mixtures
- Cyclic thermodynamic processes

**Understand and apply:**

- Phase diagrams
- The first law of thermodynamics to closed and open systems
- The second law of thermodynamics to various systems

Students will understand:

**Concepts of:**

- System and state
- Processes and process variables

**Thermodynamic principles:**

- First law of thermodynamics
- Second law of thermodynamics

**Behavior of:**

- Ideal gases and their state variables
- Gas mixtures, moist air, and steam

**Analysis of:**

- Phase diagrams
- Cyclic processes in power-generating and work-absorbing machines
- Selected adiabatic flow processes

**Learning outcomes**

Students gain the ability to distinguish clearly between state variables and process variables, enabling precise description of system behaviour. They learn to calculate specific gas constants, determine state variables in the two-phase region, and evaluate properties of ideal gases, gas mixtures, and cyclic thermodynamic processes. They develop competence in applying phase diagrams as well as the first and second laws of thermodynamics to both closed and open systems. They build a solid conceptual foundation covering systems, states, processes, ideal-gas behaviour, moist air, steam, and selected adiabatic flow processes. Finally, they understand and analyse cyclic processes in power-generating and work-absorbing machines using governing equations such as continuity, energy, and momentum conservation.

| Teaching and learning methods |
| --- |
| |
| **Reading list** |
| |

# Electrical Drives, Power Grids and Safety (EANz)

(Automation and Robotics, B.Eng., SPO 2025)

| | |
|---|---|
| **Summary** | The module teaches essential principles of DC and three-phase machines along with core electrical-grid analysis, enabling students to understand machine operation and perform key calculations for power systems. |
| **Instructor responsible for module** | Prof. Dr. Omid Forati Kashani |
| **Lecturer** | Prof. Dr. Omid Forati Kashani |
| **Language of instruction and examination** | **Use in other study programs** |
| English | |

| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
|---|---|---|---|
| 4th semester<br>3rd theoretical study phase | Compulsory module | One semester | Once a year in summer semester |

**WORK AND EXAM PERFORMANCE**

| | |
|---|---|
| **Participation requirements** | Prior knowledge about complex calculation in the field of AC-Current and vector diagrams. Basic knowledge about magnetic fields and electronic components. Knowledge about mechanics and relations between mechanical quantities. |
| **ECTS-Credits** | 5 |
| **Factor of calculation towards degree grade** | 2 |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 60 contact hours<br>▪ 90 hours of self-study |
| **Contact hours per week (SWS)** | In-person lecture (2 SWS), in-person exercise (1 SWS), in-person practical work (1 SWS) / 4 SWS |
| **Risk assessment for pregnant women and mothers** | Green |

| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
|---|---|---|
| Seminar-based teaching, exercise<br>4 SWS | Written exam (90-120 min.)<br>Practical coursework (laboratory report, survey, project or work placement report) | |

## CONTENT, METHODS AND RESULTS

### Course content

DC Machines

- Structure and mode of operation, armature winding of a DC machine, air gap fields and operating behavior, voltage generation and torque, types of DC machines, characteristics and control of DC machines, no-load characteristic, speed-torque characteristic, methods for speed changing
- Structure and mode of operation of power converters for drives with DC Machines: buck converters, boost converters, four-quadrant converters.

Introduction to three-phase systems

- Balanced three-phase system, unbalanced three-phase system, currents and voltages of balanced and unbalanced systems. Three-phase power, power factor.

Three-phase induction Machines

- Generation of rotating magnetic fields, displaced three-phase windings
- Structure and operation of induction Machines, voltage equations and equivalent circuit, power balance, speed- or slip-torque characteristic curve, speed control of induction Machines, operating range of the three-phase induction Machines, starting, special designs of the squirrel-cage rotor.

Three-phase synchronous Machines

- Structure and operation of synchronous Machines, equivalent circuit and vector diagram of cylindrical-rotor synchronous Machines, island mode and grid connected operation of the cylindrical-rotor synchronous Machines, V-curves of the cylindrical-rotor synchronous Machines, torque and stability of the cylindrical-rotor synchronous Machines, structure and special features of the salient pole Machines, torque and stability of the salient pole machines.

Power grids and safety

- Types of energy transmission (direct current, alternating current, three-phase current), power and power measurement in three-phase power grids. Short-circuit calculations (balanced and simple cases of unbalanced circuits), power grid configuration types (TN, TT, IT), fuse elements, protection regulations. Cable structures, installation methods, voltage drop calculations.

### Learning outcomes

In this module students understand fundamentals of DC Machines and topologies of static converters which can be used feeding DC Machines. They also apply fundamentals of three-phase systems generating a rotational magnetic field in a three-phase machine. Based on that rotating magnetic field the students understand how induction and synchronous Machines work. They will be able to draw and apply various characteristic curves of three-phase Machines, gaining the ability to solve electromechanical problems in steady state cases regarding electrical and mechanical quantities.

In electrical grids part of the module students apply the fundamentals of electrical energy transmission and power analysis in three-phase grids. They will know the advantages and disadvantages of different grid configurations and their safety aspects. They will be also familiar with calculation methods for short circuit currents; voltage drops and cable dimensioning.

### Teaching and learning methods

Blackboard, overhead / beamer / document camera /white board / Electronically provided work documents and exercises / practical exercises on the test bench in the laboratory

| Reading list |
| --- |
| ▪ Rolf Fischer, elektrische Maschinen, Karl Hanser Verlag München<br>▪ Helmut Späth, elektrische Maschinen und Strom-richter, Verlag Braun Karlsruhe<br>▪ Johannes Teigelkötter, Energieeffiziente elektrische Antriebe, Springer Verlag<br>▪ Joachim Specovius, Grundkurs Leistungselektronik, Springer Verlag<br>▪ Germar Müller und Bernd Ponik, Grundlagen elektrischer Maschinen, WILEY-VCH Verlag GmbH & Co. KGaA<br>▪ Gerhard Kiefer, VDE 0100 und die Praxis; VDE Verlag<br>▪ Ismail Kasikci, Projektierung von Niederspannungs- und Sicherheitsanlagen, Hüthig und Pflaum<br>▪ Klaus Heuck, Klaus-Dieter Dettmann; elektrische Energieversorgung; Vieweg-Verlag |

# Control Systems

(Automation and Robotics, B.Eng., SPO 2025)

| | |
|---|---|
| Summary | In this module, basic competencies in linear systems modeling, analysis and controller design are acquired. Students will be able to describe systems and their characteristics in various domains, combine selected controllers and plants and design control-loops with respect to given performance requirements in time- and frequency domains. |
| Instructor responsible for module | Prof. Dr. Kolja Kühnlenz |
| Lecturer | Prof. Dr. Kolja Kühnlenz |
| Language of instruction and examination | Use in other study programs |
| English | B.Eng. Mechanical Engineering<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics |

| Semester and study phase | Module category | Duration of module | Frequency of module offer |
|---|---|---|---|
| 4th semester<br>3rd theoretical study phase | Compulsory module | One semester | Once a year in summer semester |

WORK AND EXAM PERFORMANCE

| | |
|---|---|
| Participation requirements | |
| ECTS-Credits | 5 ECTS |
| Factor of calculation towards degree grade | 2 |
| Workload | Overall workload: 150 hours, comprising<br>▪ 60 hours on-site and online lecture (alternating)<br>▪ 90 hours self-study |
| Contact hours per week (SWS) | 4 |
| Risk assessment for pregnant women and mothers | Green |

| Type and scope of the course<br>Examination method/ | Examination method/<br>Requirements for the allocation of credit points | Approved examination aids |
|---|---|---|
| Seminar-based teaching, exercise<br>4 SWS | Written exam (90-120 min.) | |

CONTENT, METHODS AND RESULTS

| Course content |
| --- |
| **Systems modeling and analysis**<br>System modeling and representation<br>▪ differential equations, transfer function, Nyquist-plot, Bode-diagram, state-space<br>▪ analysis of system characteristics<br>▪ linearization<br>▪ Closed-loop structure<br><br>**Control plants**<br>Typical controllers and plants<br>▪ P, I, D, PTn,PDT1<br><br>**Stability**<br>Analysis of systems stability<br>▪ BIBO and Lypubov-Stability<br>▪ Routh-Hurwitz criterion<br>▪ Lypunov’s direct method<br><br>**Closed-loop control**<br>Structures and performance criteria<br>▪ typical controller-plant combinations<br>▪ performance parameters<br>▪ controller design in time- and frequency domain |
| Learning outcomes |
| Students understand dynamic systems using tools such as differential equations, transfer functions, Bode diagrams, Nyquist plots, and state-space models. They gain the ability to analyse system behaviour, perform linearization, and understand closed-loop structures. The student becomes familiar with typical controllers and plants—including P, I, D, PTn, and PDT1—and learns how these elements interact in practical control setups. They develop competence in evaluating system stability using concepts like BIBO stability, Lyapunov stability, the Routh-Hurwitz criterion, and Lyapunov’s direct method. Finally, they learn to design closed-loop controllers in both the time and frequency domains, applying performance criteria to typical controller-plant combinations. |
| Teaching and learning methods |
| |
| Reading list |
| |

# Measurement Technology (MT)

(Automation and Robotics, B.Eng., SPO 2025)

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|---|---|---|---|
| **Summary** | When taking measurements, it is important to minimize the inevitable measurement error that occurs depending on the equipment used and its surroundings. The module Measurement Technology covers how measurement errors and uncertainties occur, how to quantify, minimize and handle them. This is done by going through the basic concepts of metrology and followed by addressing a range of measuring techniques and instruments with their characteristic behaviour. The combined lecture/exercise is accompanied by laboratory exercise to gain hands-on experience on the subject. | | |
| **Instructor responsible for module** | Prof. Dr. Bettina Friedel | | |
| **Lecturer** | Prof. Dr. Bettina Friedel | | |
| **Language of instruction and examination** | **Use in other study programs** | | |
| English | B.Eng. Mechanical Engineering<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics | | |
| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
| 2nd semester<br>2nd theoretical study phase | Compulsory module | One semester | Once a year in summer semester |
| **WORK AND EXAM PERFORMANCE** | | | |
| **Participation requirements** | Basic knowledge of physics (in particular electricity) | | |
| **ECTS-Credits** | 5 ECTS | | |
| **Factor of calculation towards degree grade** | 2 | | |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 60 contact hours/lab<br>▪ 90 hours of self-study | | |
| **Contact hours per week (SWS)** | 4 SWS | | |
| **Risk assessment for pregnant women and mothers** | Green | | |

| Type and scope of the course<br>Examination method/ | Examination method/<br>Requirements for the allocation of credit points | Approved examination aids |
|---|---|---|
| Seminar-based teaching, exercise, internship<br>3 SWS Seminar + 1 SWS integrated exercises | Written exam (90-120 min.) | non-programmable calculator, provided formulary |

## CONTENT, METHODS AND RESULTS

### Course content

- Basic concepts of measurements: units and standards, traceability, calculation of uncertainty, types of measurement errors, error propaga-tion, documentation
- Measuring Instruments: Principle of measurement, structure/characteristics of analogue and digital multimeters, princi-ple/operation of analogue and digital oscilloscopes
- Sensors: physical principles, common types, fabrication technologies, applications
- Methods for measurement of static and dynamic electrical quantities: Current/voltage measurement, transient measurements, measurement range extension and measuring bridges, measurement of resistance and power, time and frequency, and other quantities
- Periodic Measurement Quantities: Averaging measured values from time diagrams, transformation to the frequency domain, representation of periodic measurement quantities as spectra, deriving characteristic values thereof and analysis of relationships between time and the spectrum
- Digital Measurement Technology: Sampling and amplitude quantization, quantization uncertainty, analogue/digital converters
- Practical Experiments: Application of the theoretical content, such as basic measurement methods and characteristics of peri-odic measurement signals

### Learning outcomes

The course introduces fundamental measurement concepts including units, standards, uncertainty, and common measurement errors. Students learn how measuring instruments such as multimeters, oscilloscopes, and various sensors work, along with methods for measuring static and dynamic electrical quantities. They also study periodic signals in both the time and frequency domains and gain an understanding of digital measurement techniques like sampling and quantization. Through practical experiments, students apply these theoretical principles and develop hands-on skills for analysing and interpreting electrical measurement data.

### Teaching and learning methods

on-site beamer-based presentation with integrated problem-solving sessions and discussion; electronic lecture notes

### Reading list


- # Raghavendra, N. V., & Krishnamurthy, L. (2013). Engineering Metrology and Measurements. Oxford University Press. ISBN 978-0-19-808549-2
- # Morris, A. S. (2001). Measurement and instrumentation principles (3rd ed.). Butterworth-Heinemann. ISBN 978-0-7506-5081-6
- # Tumanski, S. (2006). Principles of electrical measurement. CRC Press. ISBN 978-0-7503-1038-3
- # Bentley, J. P. (2005). Principles of measurement systems (4th ed.). Pearson Education. ISBN 978-0-13-043028-1

# Fundamentals of Electrical Engineering (FEE)

(Automation and Robotics, B.Eng., SPO 2025)

| | |
|---|---|
| **Summary** | The module covers fundamentals of electrical engineering, focusing on direct and alternating current circuits, including analysis methods and components. Key topics include electric and magnetic fields, field strength, voltage, potential, and capacitance. It also addresses material behavior in fields, electromagnetic induction, and energy and force calculations. |
| **Instructor responsible for module** | Prof. Dr. Bernd Hüttl |
| **Lecturer** | Prof. Dr. Bernd Hüttl |
| **Language of instruction and examination** | **Use in other study programs** |
| English | B.Eng. Mechanical Engineering<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics |

| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
|---|---|---|---|
| 2nd semester<br>2nd theoretical study phase | Compulsory module | One semester | Once a year in summer semester |

| **WORK AND EXAM PERFORMANCE** | |
|---|---|
| **Participation requirements** | |
| **ECTS-Credits** | 5 ECTS |
| **Factor of calculation towards degree grade** | 2 |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 45 hours lectures<br>▪ 105 hours self-study |
| **Contact hours per week (SWS)** | 4 |
| **Risk assessment for pregnant women and mothers** | Green |

| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
|---|---|---|
| Seminar-based teaching, exercise<br>4 SWS | Written exam (90-120 min.) | Own formula collection (outcome of course)<br>Pocket calculator |

## CONTENT, METHODS AND RESULTS

### Course content

Direct current technology

- Simple electrical direct current circuits: Ohm's law, mesh-, node-, voltage- and current divider rules,
- Model of ideal and real linear voltage and current sources,
- Methods for calculating linear direct current networks: branch current-, mesh current- and node potential methods.

Alternating current technology

- Stationary sinusoidal alternating current in real representation,
- Linear two-pole alternating current technology: capacitors and coils,
- Simple circuits (series and parallel circuits) and oscillating circuits.

Electric field

- Introduction to the topics of electric charge, field strength, voltage, potential and capacitance,
- Calculation of electrostatic fields and potential fields for simple geometries,
- Matter in the electric field and polarization; energy and forces of the electric field,
- Fields of layered arrangements,
- Electric flow field.

Magnetic field

- Introduction to the static magnetic field in a vacuum: magnetic phenomena, Lorentz force and magnetic flux density, flow law and magnetic field strength,
- Magnetic field in matter: para-, dia- and ferromagnetism, permeability, simple magnetic circuits,
- Electromagnetic induction law: motion and rest induction, self-induction and mutual induction,
- Energy and forces of the magnetic field.

### Learning outcomes

After attending this module, students are aware of fundamental electrical engineering. Students are able to understand the basics of dircect and alternating current technology within circuits with linear two-poles. Moreover the basics of electric and magnetic fields and electromagnetic induction are understood and are available as basic knowledge to solve simple problems and discuss easy applications.

### Teaching and learning methods

The module consists of a series of lectures. In these lectures, the theoretical basics are taught and exercises are carried out together. In special exercise sessions, the tasks from the exercise sheets (if necessary) are discussed and solved together. The script is created using an electronic whiteboard (iPad) and is available as pdf-file. All graphics and circuits are presented in digital form.

| Reading list |
| --- |
| ▪ “Fundamentals of Electric Circuits”, Ch. Alexander, M. Sadiku, McGraw-Hill Education, ISBN-13 : 978-1260570793<br>▪ “Fundamentals of Applied Electromagnetics”, F. Ulaby, U. Ravaioli, Pearson Education, ISBN-13 : 978-1292436739<br>▪ “Electrical Engineering: Fundamentals”, V. Hacker, Ch. Sumereder, De Gruyter Oldenbourg; ISBN-13 : 978-3110521023<br>▪ “Electrical Engineering: Principles & Applications, Global Edition: principles and applications”, A. Hambley, Pearson; ISBN-13 : 978-1292223124<br>▪ “Grundgebiete der Elektrotechnik, Bd. 1 und 2”, A. Führer, K. Heidemann, W. Nerreter: Hanser Verlag; ISBN-13 : 978-3446459533 |

# Programming (PG)

(Automation and Robotics, B.Eng., SPO 2025)

| | | | |
|---|---|---|---|
| **Summary** | The lecture provides in-depth knowledge of Python programming fundamentals, including variables, core data types, expressions, and essential control structures such as conditionals and loops. Students learn to work with key data structures, write functions, handle files and exceptions, and structure code effectively. Additionally, they develop foundational skills in object-oriented programming and learn to use and create modules and packages to build more organized and powerful programs. | | |
| **Instructor responsible for module** | Prof. Dr. Jochen Merhof | | |
| **Lecturer** | Prof. Dr. Jochen Merhof | | |
| **Language of instruction and examination** | **Use in other study programs** | | |
| English | B.Eng. Mechanical Engineering<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics | | |
| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
| 2nd semester<br>2nd theoretical study phase | Compulsory module | One semester | Once a year in summer semester |
| **WORK AND EXAM PERFORMANCE** | | | |
| **Participation requirements** | | | |
| **ECTS-Credits** | 5 ECTS | | |
| **Factor of calculation towards degree grade** | 2 | | |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 45 hours lectures<br>▪ 105 hours self-study | | |
| **Contact hours per week (SWS)** | 4 | | |
| **Risk assessment for pregnant women and mothers** | Green | | |

| Type and scope of the course<br>Examination method/ | Examination method/<br>Requirements for the allocation of credit points | Approved examination aids |
|---|---|---|
| Seminar-based teaching, exercise<br>4 SWS | Written exam (90-120 min.) | |

## CONTENT, METHODS AND RESULTS

### Course content

**Fundamentals of Programming with Python**
What is programming? Why Python?
Setting up the development environment

**Variables, Data Types, and Expressions**
Variable assignment and core data types (int, float, str, bool)
Type conversions and basic operations (arithmetic, comparison, logical)

**Control Structures**
Conditional statements: if, elif, else
Loops: for, while, with break and continue
Nested conditions and loops

**Basic Data Structures and Functions**
Lists and tuples: creation, access, modification
Dictionaries and sets: key-value pairs, set operations
Defining and calling functions
Parameters, return values, scope of variables

**Files and Exceptions**
Reading/writing files, file modes
Basic exception handling with try, except, finally

**Object-Oriented Programming**
Classes, objects, constructors
Inheritance, polymorphism, method overriding

### Learning outcomes

The student can develop Python programs using variables, data types, expressions, control structures, and basic data structures to solve computational problems effectively. He can design modular and robust applications by implementing functions, handling files, and managing runtime errors through exception handling techniques. He can apply object-oriented programming principles, including classes, inheritance, polymorphism, and method overriding, to create reusable and maintainable software solutions.

| Teaching and learning methods |
| --- |
| |
| **Reading list** |
| |

# Fundamentals of Business Administration

(FBusiAdmin)

(Automation and Robotics, B.Eng., SPO 2025)

| | | | |
|---|---|---|---|
| **Summary** | Within the framework of this lecture, the fundamentals of business administration will be covered. In particular, students will be enabled to understand basic business terms and economic contexts, know and describe the most important constitutive decisions of a company, analyze and explain the management process of any company, and link the elements of this process with the company's goals. Furthermore, the aim of this lecture is to explain the essential functions in the processes of business performance creation and to demonstrate their interaction. | | |
| **Instructor responsible for module** | | | |
| **Lecturer** | | | |
| **Language of instruction and examination** | **Use in other study programs** | | |
| English | B.Eng. Mechanical Engineering | | |
| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
| 3rd term, 2nd theoretical study phase | Compulsory module | One term | Once a year in winter term |
| **WORK AND EXAM PERFORMANCE** | | | |
| **Participation requirements** | | | |
| **ECTS-Credits** | 5 ECTS | | |
| **Factor of calculation towards degree grade** | 2 | | |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 45 hours lectures<br>▪ 105 hours self-study | | |
| **Contact hours per week (SWS)** | 4 | | |
| **Risk assessment for pregnant women and mothers** | Green | | |

| Type and scope of the course<br>Examination method/ | Examination method/<br>Requirements for the allocation of credit points | Approved examination aids |
|---|---|---|
| Seminar-based teaching, exercise<br>4 SWS | Written exam (90-120 min.) | |

**CONTENT, METHODS AND RESULTS**

**Course content**

**Introduction to Business Administration**

▪ Terms & General Contexts in Business Administration

▪ Development of Business Administration

**Management Process**

▪ Corporate Goals, ▪ Planning

▪ Decision-Making

▪ Control

▪ Organization

**Constitutive Decisions**

▪ Business Model, ▪ Location Choice

▪ Cooperation, ▪ Legal Form

**Individual Functional Areas According to Porter's Value Chain**

▪ Research and Development

▪ Procurement and Materials Management

▪ Production

▪ Marketing and Sales

▪ Logistics

▪ Customer Service

▪ Finance

▪ Human Resources

▪ IT

**Learning outcomes**

Students will understand the management process, including how organizations set goals, plan activities, make decisions, control outcomes, and structure internal workflows. They will learn how constitutive decisions such as choosing a business model, selecting a location, forming cooperations, and determining a legal form shape a company’s long-term direction. They will be able to explain how each value-chain function—from research and development to customer service—contributes to creating and delivering value. They will gain insight into essential operational areas like finance, human resources, and IT and how these support overall business performance. By learning these foundations, students will be equipped to analyze how companies operate, make strategic choices, and coordinate functional areas effectively.

**Teaching and learning methods**

| Reading list |
| --- |
| |

# Third theoretical Study Phase – Semester 5 and 6

## Automatisierungstechnik (Factory Automation, AU2)

(Automation and Robotics, B.Eng., SPO 2025)

| | |
|---|---|
| **Summary** | Automated production systems integrate advanced automation technologies to optimize manufacturing processes, with performance evaluated through indicators such as availability, process data analysis, and Overall Equipment Effectiveness (OEE). Sensor and actuator technologies provide the foundation for process measurement, testing, and control by applying various measurement principles and diagnostic methods. Condition monitoring utilizes the acquisition and statistical analysis of measurement data, including parameters such as mean value, RMS, crest factor, skewness, kurtosis, and Fourier analysis, to assess system health and process stability. Communication in automation technology relies on industrial networks, communication architectures, transmission methods, and protocols such as TCP/IP, OPC UA, MQTT, EtherCAT, and ProfiNet to ensure reliable data exchange and interoperability. The field is further supported by cybersecurity mechanisms, including encryption and certificate management, as well as practical laboratory applications involving process optimization, industrial communication, and automated process control systems. |
| **Instructor responsible for module** | Prof. Dr.-Ing. Matthäus Brela |
| **Lecturer** | Prof. Dr.-Ing. Matthäus Brela |
| **Language of instruction and examination** | **Use in other study programs** |
| German | B.Eng. Mechanical Engineering |

| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
|---|---|---|---|
| 6th semester<br>3rd theoretical study phase | Compulsory module | One semester | Once a year in summer semester |

| **WORK AND EXAM PERFORMANCE** | |
|---|---|
| **Participation requirements** | None |
| **ECTS-Credits** | 5 ECTS |
| **Factor of calculation towards degree grade** | 2 |

| | | |
|---|---|---|
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 60 hours lectures<br>▪ 90 hours self-study | |
| **Contact hours per week (SWS)** | 4 in-person seminar (1 SWS) and practical work (3 SWS) | |
| **Risk assessment for pregnant women and mothers** | Green | |
| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
| Seminar-based teaching, exercise<br>4 SWS | Practical coursework (laboratory report, survey, project or work placement report) | |

## CONTENT, METHODS AND RESULTS

**Course content**

**Automated Production Systems**

• Degree of automation in production systems, process data, process technology, availability, and Overall Equipment Effectiveness (OEE).

**Sensors and Actuators**

• Measurement principles, requirements for testing processes, development of testing processes, and sensor technology.

**Test Technology and Diagnosis**

• Computer-aided diagnosis, measurement and process capability, etc.

**Condition Monitoring**

• Acquisition and processing of measurement data. Statistical methods for process data analysis: mean value, RMS, crest factor, skewness, kurtosis, Fourier analysis, etc.

**Communication in Automation Technology**

• Networks, network topology, network components, OSI layer model, message structure, Ethernet and Industrial Ethernet, transmission methods in fieldbus systems, token passing, TDMA, frame summation methods, synchronization mechanisms, etc.

**Protocols in Automation Technology**

• RS232, RS485, TCP/IP, OPC-UA, MQTT, Modbus, EtherCAT, ProfiNet, Profibus, PowerLink, Ethernet/IP, DeviceNet, EnOcean, KNX, LON, DALI, IO-Link, AS-Interface, CANopen, etc.

**Security**

•Security mechanisms, certificates, certificate exchange, encryption mechanisms.

Laboratory Experiments

• Process optimization with PlantSimulation

• Communication and data exchange: RS232, TCP/IP, OPC-UA, etc.

• Process control with Fischertechnik Factory

| Learning outcomes |
| --- |
| • Students understand the roles of each level in the automation pyramid.<br>• They are aware of the basic differences between process and measurement capability, as well as between acceptance testing and calibration.<br>• They can independently determine process and measurement capability and differentiate between quality assurance, process optimization, and fault diagnosis.<br>• They are capable of determining process capability indices and optimizing them through process simulations.<br>• They are able to design a control system for integrated processes, implement various communication protocols, and analyze and optimize process controls.<br>• They can commission a DC motor, stepper motor, axis objects, and the associated final stages.<br>• They can mathematically formulate methods for condition monitoring, select suitable approaches based on practical application scenarios, and develop CM software.<br>• They can name various protocols within the OSI layer model and subsuming messages in automation technology accordingly.<br>• They understand the role of a process control system (Manufacturing Execution System – MES).<br>• They can explain the basic concept of IEC 1855 and understand synchronization mechanisms in control technology.<br>• They can describe the reference architecture model of Industry 4.0.<br>• They can enable communication between processes using OPC-UA and MQTT protocols. |
| **Teaching and learning methods** |
| Projector and board/whiteboard, simulation programs, electronic scripts and working materials, practical exercises. |
| **Reading list** |
| Vogel-Heuser, B.; Bauernhansl, T.; ten Hompel, M.: Handbook Industry 4.0, 2nd edition, Springer Vieweg, 2017<br>Goehner, P.: Agent Systems in Automation Technology, 1st edition, Springer Vieweg, 2013<br>Reinheimer, S. (Ed.): Industry 4.0 – Challenges, Concepts and Practical Examples, 1st edition, Springer Vieweg, 2017<br>Robert Bosch GmbH (Ed.): Pocket Book for Crafts and Industry, 6th edition, Senner-Druck, Nürtingen, 2017<br>Seitz, M.: Programmable Logic Controllers for Factory and Process Automation, 4th edition, Carl Hanser Ver-lag, 2015<br>Langmann, R.: Pocket Book of Automation, 3rd edition, Carl Hanser Verlag, 2017 |

# Computermesstechnik
## (Computer based Measurement Technology)

(Automation and Robotics, B.Eng., SPO 2025)

| | | | |
|---|---|---|---|
| **Summary** | | | |
| **Instructor responsible for module** | Prof. Dr. Merhof | | |
| **Lecturer** | Prof. Dr. Merhof | | |
| **Language of instruction and examination** | **Use in other study programs** | | |
| German | B.Eng. Mechanical Engineering | | |
| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
| 5rd term<br>3rd theoretical study phase | Compulsory module | One semester | Once a year in winter semester |
| **WORK AND EXAM PERFORMANCE** | | | |
| **Participation requirements** | | | |
| **ECTS-Credits** | 5 ECTS | | |
| **Factor of calculation towards degree grade** | 2 | | |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 45 hours lectures<br>▪ 105 hours self-study | | |
| **Contact hours per week (SWS)** | 4 | | |
| **Risk assessment for pregnant women and mothers** | Green | | |

| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
|---|---|---|
| Seminar-based teaching, exercise<br>4 SWS | Written exam (90-120 min.) | |

**CONTENT, METHODS AND RESULTS**

| Course content |
| --- |
| This module provides students with a comprehensive introduction to the principles and practices of computer-integrated measurement and testing systems. The focus lies on the development of software solutions for capturing, processing, and visualizing measurement data in industrial and laboratory environments.<br>Students will acquire the ability to analyze and structure basic measurement tasks and will gain practical experience in designing and implementing software for data acquisition using the Python programming language. Key aspects include signal processing, real-time data handling, and visualization techniques.<br>The course also covers the most relevant hardware interfaces for connecting measurement instruments, such as RS232, GPIB, USB, and LAN. Students will become familiar with access mechanisms, learn how to communicate with instruments using the SCPI command language, and develop the skills to create basic device drivers independently.<br>In addition, the module addresses fundamental concepts of digital measurement data acquisition, including sampling, quantization, and error analysis. Students will be able to assess how these factors affect the quality and accuracy of measurement results.<br>An important part of the course is devoted to networked applications. Topics include the ISO/OSI communication model, the TCP/IP protocol stack, local area networks (LAN), and internet-based communication. Students will explore server/client architectures and the challenges involved in the digital transmission and storage of measurement data.<br>Upon successful completion of the module, students will be equipped with the essential competencies to design and implement computer-based measurement systems and understand their integration into modern production and testing environments. |
| **Learning outcomes** |
| |
| **Teaching and learning methods** |
| |
| **Reading list** |
| |

# Softwareentwurf in der Automatisierungstechnik (Software Development in Automation, SwAu)

(Automation and Robotics, B.Eng., SPO 2025)

| | |
|---|---|
| **Summary** | |
| **Instructor responsible for module** | |
| **Lecturer** | |
| **Language of instruction and examination** | **Use in other study programs** |
| German | BA Automatisierungstechnik und Robotik<br>BA Elektro- und Informationstechnik<br>BA Energietechnik und Erneuerbare Energien<br>BA Informatik |

| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
|---|---|---|---|
| 5th semester<br>3rd theoretical study phase | Compulsory module | One semester | Once a year in winter semester |

**WORK AND EXAM PERFORMANCE**

| | |
|---|---|
| **Participation requirements** | |
| **ECTS-Credits** | 5 ECTS |
| **Factor of calculation towards degree grade** | 2 |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 60 hours on-site and online lecture (alternating)<br>▪ 90 hours self-study |
| **Contact hours per week (SWS)** | 4 |
| **Risk assessment for pregnant women and mothers** | |

| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
|---|---|---|
| Seminar-based teaching, exercise<br>4 SWS | Written exam (90-120 min.) | |

**CONTENT, METHODS AND RESULTS**

| Course content |
| --- |
| |
| **Learning outcomes** |
| |
| **Teaching and learning methods** |
| |
| **Reading list** |
| |

| Course content |
| --- |
| ▪ targets of producing enterprises<br>▪ different forms of organization of enterprises<br>▪ process developement<br>▪ organization and total quality management (TQM)<br>▪ international standards and process modelling<br>▪ quality management during the product lifecycle<br>▪ quality and digitalization |
| **Learning outcomes** |
| Students understand the objectives of producing enterprises and can explain different organizational structures, their processes, and the role of organization and Total Quality Management (TQM) in achieving business goals. They are familiar with process development, international standards, process modelling methods, and the application of quality management throughout the entire product lifecycle. In addition, they understand how digitalization supports quality management, improves process efficiency, and contributes to continuous improvement in modern enterprises. |
| **Teaching and learning methods** |
| |
| **Reading list** |
| |

# Technical German 3, Level B2.2 (TG 3)

| | |
|---|---|
| **Summary** | |
| **Instructor responsible for module** | Dr. Edgar Skvorcov |
| **Lecturer** | Dr. Edgar Skvorcov |
| **Language of instruction and examination** | **Use in other study programs** |
| German | B.Eng. Electrical Engineering for Sustainable and Renewable Energy |

| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
|---|---|---|---|
| 3rd semester<br>2nd theoretical study phase | Compulsory module | One semester | Once a year in winter semester |

**WORK AND EXAM PERFORMANCE**

| | |
|---|---|
| **Participation requirements** | |
| **ECTS-Credits** | 5 ECTS |
| **Factor of calculation towards degree grade** | 0,5 |
| **Workload** | 150 hours |
| **Contact hours per week (SWS)** | 4 |
| **Risk assessment for pregnant women and mothers** | Green |

| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
|---|---|---|
| Seminar-based teaching, exercise<br>4 SWS | Written exam (90-120 min.) | |

**CONTENT, METHODS AND RESULTS**

| |
|---|
| **Course content** |
| |
| **Learning outcomes** |
| |

| Teaching and learning methods | | | |
|---|---|---|---|
| | | | |
| **Reading list** | | | |
| | | | |
| Introduction in Scientific Writing, Level C1.1<br>(Automation and Robotics, B.Eng., SPO 2025) | | | |
| **Summary** | | | |
| **Instructor responsible for module** | Dr. Edgar Skvorcov | | |
| **Lecturer** | Dr. Edgar Skvorcov | | |
| **Language of instruction and examination** | **Use in other study programs** | | |
| German | B.Eng. Mechanical Engineering<br>B.Eng. Digital Business Models and Technologies<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics | | |
| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
| 6nd semester<br>2nd theoretical study phase | Compulsory module | One semester | Once a year in summer semester |
| **WORK AND EXAM PERFORMANCE** | | | |
| **Participation requirements** | | | |
| **ECTS-Credits** | 5 ECTS | | |
| **Factor of calculation towards degree grade** | 2 | | |
| **Workload** | 150 hours | | |
| **Contact hours per week (SWS)** | 4 | | |
| **Risk assessment for pregnant women and mothers** | Green | | |
| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** | |
| Seminar, seminar-based teaching, exercise<br>4 SWS | Practical course project (report, survey, project, or field report) | | |
| **CONTENT, METHODS AND RESULTS** | | | |

| Course content |
| --- |
| |
| **Learning outcomes** |
| |
| **Teaching and learning methods** |
| |
| **Reading list** |
| |

# Introduction in Scientific Writing, Level C1.1

(Automation and Robotics, B.Eng., SPO 2025)

| | |
|---|---|
| **Summary** | |
| **Instructor responsible for module** | Dr. Edgar Skvorcov |
| **Lecturer** | Dr. Edgar Skvorcov |
| **Language of instruction and examination** | **Use in other study programs** |
| German | B.Eng. Mechanical Engineering<br>B.Eng. Digital Business Models and Technologies<br>B.Eng. Electrical Engineering for Sustainable and Renewable Energy<br>B.Eng. Engineering Physics |

| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
|---|---|---|---|
| 6nd semester<br>2nd theoretical study phase | Compulsory module | One semester | Once a year in summer semester |

| **WORK AND EXAM PERFORMANCE** | |
|---|---|
| **Participation requirements** | |
| **ECTS-Credits** | 5 ECTS |
| **Factor of calculation towards degree grade** | 2 |
| **Workload** | 150 hours |
| **Contact hours per week (SWS)** | 4 |
| **Risk assessment for pregnant women and mothers** | Green |

| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
|---|---|---|
| Seminar, seminar-based teaching, exercise<br>4 SWS | Practical coursework (laboratory report, survey, project or work placement report) | |

| **CONTENT, METHODS AND RESULTS** |
|---|
| **Course content** |
| |
| **Learning outcomes** |
| |

| Teaching and learning methods |
| --- |
| |
| **Reading list** |
| |

# Elective Subject 1

(Automation and Robotics, B.Eng., SPO 2025)

| | |
|---|---|
| **Summary** | One module must be selected from a list of modules relating to Automation and Robotics. |
| **Instructor responsible for module** | Specified in the Academic and Examination Regulations (SPO) |
| **Lecturer** | NN |
| **Language of instruction and examination** | **Use in other study programs** |
| English or German | |

| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
|---|---|---|---|
| 5th term<br>3rd theoretical study phase | Elective module | One term | Once a year in winter term |

**WORK AND EXAM PERFORMANCE**

| | |
|---|---|
| **Participation requirements** | |
| **ECTS-Credits** | 5 ECTS |
| **Factor of calculation towards degree grade** | 2 |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 45 hours lectures<br>▪ 105 hours self-study |
| **Contact hours per week (SWS)** | 4 |
| **Risk assessment for pregnant women and mothers** | |

| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
|---|---|---|
| Seminar, seminar-based teaching, exercise, internship<br>4 SWS | The course offerings are determined by the Faculty Council at the end of the current semester for the following semester. Eligible are three modules. Type, scope, and any admission requirements are specified in the Academic and Examination Regulations (SPO) | |

| CONTENT, METHODS AND RESULTS |
| --- |
| **Course content** |
| The contents of each module can be found in a separate description. |
| **Learning outcomes** |
| |
| **Teaching and learning methods** |
| |
| **Reading list** |
| |

# Elective Subject 2

(Automation and Robotics, B.Eng., SPO 2025)

| | |
|---|---|
| **Summary** | One module must be selected from a list of modules relating to Automation and Robotics. |
| **Instructor responsible for module** | Specified in the Academic and Examination Regulations (SPO) |
| **Lecturer** | NN |
| **Language of instruction and examination** | **Use in other study programs** |
| English or German | |

| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
|---|---|---|---|
| 6th term<br>3rd theoretical study phase | Elective module | One term | Once a year in summer term |

**WORK AND EXAM PERFORMANCE**

| | |
|---|---|
| **Participation requirements** | |
| **ECTS-Credits** | 5 ECTS |
| **Factor of calculation towards degree grade** | 2 |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 45 hours lectures<br>▪ 105 hours self-study |
| **Contact hours per week (SWS)** | 4 |
| **Risk assessment for pregnant women and mothers** | |

| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
|---|---|---|
| Seminar, seminar-based teaching, exercise, internship<br>4 SWS | The course offerings are determined by the Faculty Council at the end of the current semester for the following semester. Eligible are three modules. Type, scope, and any admission requirements are specified in the Academic and Examination Regulations (SPO) | |

| CONTENT, METHODS AND RESULTS |
| --- |
| **Course content** |
| The contents of each module can be found in a separate description. |
| **Learning outcomes** |
| |
| **Teaching and learning methods** |
| |
| **Reading list** |

# Third practical Study Phase – Semester 7

## Industrial Internship

(Automation and Robotics, B.Eng., SPO 2025)

| | | | |
|---|---|---|---|
| **Summary** | Practical semester in an industrial company | | |
| **Instructor responsible for module** | | | |
| **Lecturer** | | | |
| **Language of instruction and examination** | **Use in other study programs** | | |
| German | | | |
| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
| 7th term<br>4th practical study phase | Compulsory module | One term | Once a year in winter term |
| **WORK AND EXAM PERFORMANCE** | | | |
| **Participation requirements** | | | |
| **ECTS-Credits** | 25 ECTS | | |
| **Factor of calculation towards degree grade** | 0 | | |
| **Workload** | 20 weeks full time in a company | | |
| **Contact hours per week (SWS)** | 0 | | |
| **Risk assessment for pregnant women and mothers** | | | |
| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** | |
| | | | |
| **CONTENT, METHODS AND RESULTS** | | | |
| **Course content** | | | |
| Application of theoretical knowledge to questions and topics in professional practice; the professional focus should be chosen according to the personal area of specialisation; possible areas are e.g. develo-pment, design, project planning, production, production preparation and control, quality management, optimisation of technical processes. | | | |

| Learning outcomes |
| --- |
| |
| **Teaching and learning methods** |
| |
| **Reading list** |
| |

# Industrial Internship accompanying Seminar 1

(Automation and Robotics, B.Eng., SPO 2025)

| | | | |
|---|---|---|---|
| **Summary** | The seminar deals with introduction to scientific work, organisation of literature research, ability to process information | | |
| **Instructor responsible for module** | | | |
| **Lecturer** | | | |
| **Language of instruction and examination** | **Use in other study programs** | | |
| English | - | | |
| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
| 7th term<br>4th practical study phase | Compulsory module | One term | Once a year in winter term |

| | | |
|---|---|---|
| **WORK AND EXAM PERFORMANCE** | | |
| **Participation requirements** | | |
| **ECTS-Credits** | 3 ECTS | |
| **Factor of calculation towards degree grade** | 0 | |
| **Workload** | Overall workload: 112.5 hours, comprising<br>▪ 37.5 hours classroom study<br>▪ 75 hours self-study | |
| **Contact hours per week (SWS)** | 3 | |
| **Risk assessment for pregnant women and mothers** | | |
| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
| | | |

| |
|---|
| **CONTENT, METHODS AND RESULTS** |
| **Course content** |
| Identification of topics and learning fields literature research, literature procurement, information preparation, presentations, practical report, Bachelor's thesis |

| Learning outcomes |
| --- |
| |
| **Teaching and learning methods** |
| |
| **Reading list** |
| |

# Industrial Internship accompanying Seminar 2

(Automation and Robotics, B.Eng., SPO 2025)

| | | | |
|---|---|---|---|
| **Summary** | The seminar deals with project management: basic project management methods and their application, consistent planning and work on projects in a team, collaboration skills and working techniques, social skills. | | |
| **Instructor responsible for module** | | | |
| **Lecturer** | | | |
| **Language of instruction and examination** | **Use in other study programs** | | |
| English | - | | |
| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
| 7th term<br>4th practical study phase | Compulsory module | One term | Once a year in winter term |
| **WORK AND EXAM PERFORMANCE** | | | |
| **Participation requirements** | | | |
| **ECTS-Credits** | 2 ECTS | | |
| **Factor of calculation towards degree grade** | 0 | | |
| **Workload** | Overall workload: 75 hours, comprising<br>▪ 22.5 hours classroom study<br>▪ 52.5 hours self-study | | |
| **Contact hours per week (SWS)** | 2 | | |
| **Risk assessment for pregnant women and mothers** | | | |
| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** | |
| | | | |
| **CONTENT, METHODS AND RESULTS** | | | |

| Course content |
| --- |
| From the idea to the clarified assignment, project influences, roles in project management, cooperation in projects, visions and goals, procedure and milestones, overview of all project tasks, planning and control-ling of projects, risk management, structure and preparation, classic PM and agile project management. |
| **Learning outcomes** |
| |
| **Teaching and learning methods** |
| |
| **Reading list** |
| |

# Fourth Study Phase Final Thesis – Semester 8

## Elective Subject 3

(Automation and Robotics, B.Eng., SPO 2025)

| | | | |
|---|---|---|---|
| **Summary** | One module must be selected from a list of modules relating to Automation and Robotics. | | |
| **Instructor responsible for module** | Specified in the Academic and Examination Regulations (SPO) | | |
| **Lecturer** | NN | | |
| **Language of instruction and examination** | **Use in other study programs** | | |
| English or German | | | |
| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
| 8th term<br>4th study phase | Elective module | One term | Once a year in summer term |
| **WORK AND EXAM PERFORMANCE** | | | |
| **Participation requirements** | | | |
| **ECTS-Credits** | 5 ECTS | | |
| **Factor of calculation towards degree grade** | 2 | | |
| **Workload** | Overall workload: 150 hours, comprising<br>▪ 45 hours lectures<br>▪ 105 hours self-study | | |
| **Contact hours per week (SWS)** | 4 | | |
| **Risk assessment for pregnant women and mothers** | | | |

| Type and scope of the course<br>Examination method/ | Examination method/<br>Requirements for the allocation of credit points | Approved examination aids |
|---|---|---|
| Seminar, seminar-based teaching, exercise, internship<br>4 SWS | The course offerings are determined by the Faculty Council at the end of the current semester for the following semester. Eligible are three modules. Type, scope, and any admission requirements are specified in the Academic and Examination Regulations (SPO) | |
| **CONTENT, METHODS AND RESULTS** | | |
| **Course content** | | |
| The contents of each module can be found in a separate description. | | |
| **Learning outcomes** | | |
| | | |
| **Teaching and learning methods** | | |
| | | |
| **Reading list** | | |

# Engineering Project

(Automation and Robotics, B.Eng., SPO 2025)

| | | | |
|---|---|---|---|
| **Summary** | The practical engineering project serves as a supplement to the Bachelor's thesis. Specialist knowledge and scientific methods are deepened. Usually, a topic related or interlinked with the Bachelor's thesis is worked on in the relevant company. | | |
| **Instructor responsible for module** | | | |
| **Lecturer** | | | |
| **Language of instruction and examination** | **Use in other study programs** | | |
| Deutsch | | | |
| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
| 8th term<br>4th degree study phase | Compulsory module | One term | Each term |
| **WORK AND EXAM PERFORMANCE** | | | |
| **Participation requirements** | | | |
| **ECTS-Credits** | 10 ECTS | | |
| **Factor of calculation towards degree grade** | 2 | | |
| **Workload** | Overall workload: 300 h (project work) | | |
| **Contact hours per week (SWS)** | 0,2 | | |
| **Risk assessment for pregnant women and mothers** | | | |

| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
|---|---|---|
| As part of the Engineering Project, faculty members from the university provide guidance.<br>0,2 SWS | Scientific report | |

**CONTENT, METHODS AND RESULTS**

| Course content |
| --- |
| ▪ Project organization and structuring<br>▪ Literature research<br>▪ Methodical knowledge acquisition<br>▪ Scientific evaluation and documentation |
| **Learning outcomes** |
| |
| **Teaching and learning methods** |
| |
| **Reading list** |
| |

# Bachelor Colloquium

(Automation and Robotics, B.Eng., SPO 2025)

| | |
|---|---|
| **Summary** | In the Bachelor Colloquium, the motivation and the main results of the Bachelor thesis are summarized and presented. The presentation serves to defend your own work and answer questions from experts and the audience. This shows that you have understood the topic well and are able to explain and discuss it. You receive valuable feedback that can be used to improve your work or for future projects. |
| **Instructor responsible for module** | |
| **Lecturer** | |
| **Language of instruction and examination** | **Use in other study programs** |
| English | |

| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
|---|---|---|---|
| 8th term<br>4th degree study phase | Compulsory module | One term | Each term |

**WORK AND EXAM PERFORMANCE**

| | |
|---|---|
| **Participation requirements** | |
| **ECTS-Credits** | 3 ECTS |
| **Factor of calculation towards degree grade** | 1 |
| **Workload** | Overall workload: 90 hours |
| **Contact hours per week (SWS)** | 0 |
| **Risk assessment for pregnant women and mothers** | |

| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** |
|---|---|---|
| | Presentation | |

**CONTENT, METHODS AND RESULTS**

| Course content |
| --- |
| ▪ Summary of engioneering and scientific results<br>▪ Designing and structuring a presentation, using suitable media<br>▪ Rhetoric in a professional context<br>▪ Discussion of scientific methods and expert knowledge |
| **Learning outcomes** |
| Student can summarize and communicate the motivation, methodology, and key engineering and scientific results of a Bachelor thesis in a clear and structured manner. They can design and deliver professional presentations using appropriate media, apply effective rhetorical techniques, and confidently defend their work in discussions with experts and peers. Furthermore, students demonstrate their ability to critically discuss scientific methods and subject-specific knowledge, respond to questions competently, and incorporate feedback for continuous improvement and future projects. |
| **Teaching and learning methods** |
| |
| **Reading list** |
| |

# Bachelor Thesis

(Automation and Robotics, B.Eng., SPO 2025)

| | | | |
|---|---|---|---|
| **Summary** | As part of the Bachelor's thesis, students usually work on an engineering problem in a company. There are a wide range of topics to choose from in the areas of development, design, modeling and simulation, testing, production and logistics, etc. The project is accompanied and supervised by a member of staff and a professor at the university. | | |
| **Instructor responsible for module** | | | |
| **Lecturer** | | | |
| **Language of instruction and examination** | **Use in other study programs** | | |
| English or German | | | |
| **Semester and study phase** | **Module category** | **Duration of module** | **Frequency of module offer** |
| 8th term<br>4th degree study phase | Compulsory module | One term | Each term |
| **WORK AND EXAM PERFORMANCE** | | | |
| **Participation requirements** | | | |
| **ECTS-Credits** | 12 ECTS | | |
| **Factor of calculation towards degree grade** | 5 | | |
| **Workload** | Overall workload: 360 hours (project work) | | |
| **Contact hours per week (SWS)** | | | |
| **Risk assessment for pregnant women and mothers** | | | |
| **Type and scope of the course**<br>**Examination method/** | **Examination method/**<br>**Requirements for the allocation of credit points** | **Approved examination aids** | |
| | Bachelor's Thesis | | |
| **CONTENT, METHODS AND RESULTS** | | | |

| Course content |
| --- |
| ▪ Project organization and structuring<br>▪ Literature research<br>▪ Methodical knowledge acquisition<br>▪ Scientific evaluation and documentation |
| **Learning outcomes** |
| Students can independently plan, organize, and structure an engineering project while working on a practical problem in an industrial environment. They can conduct systematic literature research, acquire and apply relevant technical and methodological knowledge, and develop well-founded solutions to engineering challenges. Furthermore, they demonstrate the ability to scientifically evaluate, document, and present project results in a clear and professional manner. |
| **Teaching and learning methods** |
| |
| **Reading list** |
| |

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