Faculty Engineering and Computer Science
Department of Mechanical Engineering and Production

Module Handbook

Study Program
Mechanical Engineering

01.10.2024

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Types and forms of examination and assessment

According to § 14 APSO-INGI, in the current version, the examination forms for the subsequent module handbook are defined as follows:

1. Case study (CS) (FS)
   A case study is a piece of written work presenting a solution to a set problem and the rationale for the solution proposed. It may be completed individually or in a group and involves the identification, analysis and solution of specific problems from a relevant professional field via the application of academic/scientific methods and findings. Case studies shall be undertaken alongside a particular class and must be completed in the same semester as the class and by the time the class ends. The relevant Course-Specific Course and Examination Regulations may contain more detailed provisions on the time available for the completion of case studies.

2. Written paper (WP) (H)
   A written paper is a piece of written work to be produced independently by the student outside class hours, in which the student demonstrates their ability to investigate and analyse a set question or subject independently. A maximum of three months is allowed for completion. Where a written paper constitutes a Prüfungsleistung, the relevant Course-Specific Course and Examination Regulations may specify whether or not a colloquium is to be held once the written project has been submitted. Colloquia should last between 15 and 45 minutes, and are generally to be held within one month of submission of the written paper.

3. Written examination (WE) (K)
   A written examination is completed under supervision. Students must complete the questions set on their own, either without the use of study aids or with the use of specified study aids only. Written examinations last at least 60 and no longer than 240 minutes. In cases in which a written examination takes place as an online examination under remote (video) invigilation in accordance with Section 14 d, the student taking the examination shall, upon submission of the completed examination, give a declaration in written or electronic form that they have completed the examination on their own, within the time period allowed, and without the use of any aids except those explicitly permitted.

4. Colloquium (CO) (KO)
   A colloquium may be required as part of certain types of assessment, or in combination with the Bachelor or Master thesis. A colloquium is an oral examination in which students must demonstrate their knowledge of the material examined, speaking and responding without the use of a script. A further purpose of a colloquium is to establish that written work previously submitted for assessment was all the student's own work. Colloquia last at least 15 and no more than 45 minutes, and may take place as individual or group examinations. In the case of group colloquia, the size of the group should be taken into consideration when setting the length of the colloquium.

5. Engineering design task (EDT) (KN)
   An engineering design task is a piece of written work in which students demonstrate their design skills by solving practical tasks. A maximum of three months is allowed for completion.

6. Lab work completion (LWC) (LA)
   Laboratory work is successfully completed when students have successfully conducted the experiments set by the examiner during the semester and have demonstrated their knowledge by taking part in associated colloquia and/or by submitting written records of their experimental work and/or by completing set written tasks. Colloquia last for a minimum

of 15 and a maximum of 45 minutes. The written work must be submitted by a deadline set by the examiner; the latest deadline is the end of the semester in which the class in question was taken.

7. Lab work examination (LE) (LR)
   The lab work examination consists of the lab work completion as outlined above and an additional final examination at the end of the class, which shall require the student to carry out an experiment independently. This examination shall last at least 60 and no more than 240 minutes.

8. Oral examination (OE) (M)
   In an oral examination, a student must demonstrate in discussion with the examiner that they have fully learned and understood the material on which they are being examined. Oral examinations generally last at least 15 and no more than 45 minutes, and may be conducted as individual or group examinations. They shall be conducted by one examiner and one supplementary assessor (Beisitzer*in) in accordance with Section 13 subsection 4 above. An oral examination may alternatively be conducted by two or more examiners instead of one, i.e. by a panel of examiners; in such a case, one examiner only shall be responsible for conducting the examination for each examination subject. Oral examinations are always assessed and graded by one examiner [the principal examiner, in the case of panel examinations] only, no matter whether they are conducted by several examiners or by an examiner and a supplementary assessor. The examiner responsible for grading in each case shall consider the views of the other examiners/the supplementary assessor before deciding on the grade to be awarded. A written record shall be made of the principal topics covered in each examination and its result. The record shall be signed by the examiner(s) and supplementary assessor and filed with the examination documents.

9. Project (Pro) (Pj)
   A project is an interdisciplinary task relating to the professional field towards which the degree course is principally oriented. The results/findings of projects must be documented. At least 6 and no more than 26 weeks are allowed for projects. A project generally concludes with a colloquium. The relevant Course-Specific Course and Examination Regulations may specify additional requirements in relation to a project's form, content and objective and an alternative form of final assessment instead of a colloquium.

10. Presentation (Pres) (R)
    A presentation is an oral talk lasting between 15 and 45 minutes, given on the basis of a written outline prepared by the student and followed by a facilitated discussion. Presentations should not be read out from a script; students should be able to speak spontaneously. Students must submit digital or hard copies of any presentation slides and diagrams/charts/images used to the examiner. Their written outline, which they must also submit to the examiner, should summarise their key findings and conclusions.

11. Test (T)
    Tests are pieces of written work in which students demonstrate their ability to solve set tasks in a clearly defined subject area under examination conditions. Tests last at least 15 and no more than 90 minutes. Course-Specific Course and Examination Regulations may stipulate that the results of individual tests shall be included in the overall grade for written examinations.

12. Certificate for exercises (CfE) (ÜT)
    A certificate for exercises is awarded once a student has successfully solved theoretical tasks set by the examiner in written form and has demonstrated their knowledge of the subject in a colloquium or presentation. Colloquia shall last at least 15 and no more than 45 minutes. The written work must be submitted by a deadline set by the examiner; the latest deadline

shall be the end of the semester in which the student took the class (exercise/Übung). The relevant CourseSpecific Course and Examination Regulations may stipulate other forms of assessment where useful and necessary.

13. Portfolio examination (PP)
    A portfolio examination is a type of assessment consisting of not more than ten distinct components, in at least two different forms of assessment chosen from the forms of assessment listed in Section 14 subsection 3 of these Regulations; practice tasks set during the semester may also be one of the components. At the beginning of the class or course, the member of academic staff in charge of delivering it shall determine and announce which components will comprise the portfolio examination and their weightings. Where the class concludes with a Prüfungsleistung, the overall grade for the portfolio examination shall be calculated from each individual component, weighted in accordance with the weighting announced at the outset of the course. The total workload and the difficulty level of a portfolio examination shall not exceed the workload or difficulty level that would pertain to each form of assessment used were they to be used as the sole component of the examination.

14. Take-home examination (THP)
    A take-home examination consists in the student's completion of an examination paper, comprising one or more tasks, at their home, or in another location, using only such aids as are specifically permitted and within a specified period of time. Issuance of examination papers and submission of completed examinations take place electronically. The time allowed for completion shall be at least 60 and not more than 300 minutes, and shall include the period of time during which students complete the examination and the time required for downloading and uploading the papers. The examination shall take place using software, videoconferencing or online collaboration systems, or teaching and learning platforms provided by HAW Hamburg. During the class, course or module to which the examination pertains, students shall receive the opportunity to familiarise themselves with the software, videoconferencing or online collaboration systems, or teaching and learning platforms to be used for the examination. Students shall submit, with their completed examination, a written or electronic declaration that they have completed the examination on their own, within the time period allowed, and without the use of any aids except those explicitly permitted.

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Additive Manufacturing** **Additive Fertigung**
Module number	ADDFT-E
Module coordinator/ person responsible	Herr Prof. Dr. Jens Telgkamp
Duration of the module/ semester/ frequency	1 Semester/ 4th, 5th or 6th semester/ Annually (for information in German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards. Recommended: Manufacturing Technology
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	In the lecture, students learn the essential generative manufacturing processes and their application in the industrial environment and are enabled to compare the processes in a well-founded manner. They will be able to create technological concepts, apply methods and strategies of computer-integrated development and, in particular, apply computer-aided generation and modeling of 3D geometries. The participants acquire the competence to use models strategically in the development process and to use additively manufactured components as final raw parts or finished serial parts. They will be able to select suitable processes and procure models and workpieces. Finally, they will be able to select, purchase and economically operate equipment for additive manufacturing.
Content of the module	Seminar-based teaching: • Requirements for new product development strategies • Information preparation and data exchange, interfaces • Technologies of generative/additive processes • Use of software (modeling, slicing, repair, economic assessment) • Industrial rapid prototyping / additive manufacturing systems • Applications in industrial product development • Production engineering aspects of generative manufacturing processes • Subsequent processes to finish the functional component • Design rules for additively manufactured components • Process selection and economic efficiency • Outlook and future developments Laboratory practical course: • Repair of corrupt STL models with special software • Practical examination and operation of the existing FDM system • Data preparation, construction and post-processing of the self-created model • Macroscopic and microscopic examination and discussion of defects and build patterns of different additive manufacturing processes

Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: oral examination (PL) Other possible forms of examination: Written examination Laboratory practical course: Lab work completion (SL) In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-based teaching (3 SHW), laboratory practical (1 SHW), slides, blackboard, beamer, script
Literature	Script, lecture notes In depth information (in current edition): • Gibson, J.; Rosen, D.; Stucker, B.: Additive Manufacturing Technologies; 3D Printing, Rapid Prototyping and Digital Signal Manufacturing, Springer • Harshit K. Dave; J. Paulo Davim: Fused Deposition Modeling Based 3D Printing, Springer, ISBN 978-3-030-68023-7 (print); ISBN 978-3-030-68024-4 (eBook), 2021 • Godec, D. et. al.: A Guide to Additive Manufacturing, Springer Open Access, 2022 • Zhou, K.: Additive Manufacturing Technology, Wiley • Gebhardt : Additive Fertigungsverfahren, Carl Hanser, 2016 • Berger, Hartmann, Schmid : Additive Fertigungsverfahren, Europa-Lehrmittel, 2018 • Breuninger, J.; Becker, R.; Wolf, A.; Rommel, S.; Verl, A.: Generative Fertigung mit Kunststoffen: Konzeption und Konstruktion fu?r Selektives Lasersintern. Berlin, Heidelberg: Springer, 2013

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Applied Computer Science** **Angewandte Informatik**
Module number	AINF-E
Module coordinator/ person responsible	Herr Prof. Dr. Ivo Nowak
Duration of the module/ semester/ frequency	1 Semester/ 3rd semester/ Annually (for information in German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	6 LP/ 6.00 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 102 h and Self-study: 78 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	Recommended: Mathematics 1+2, Experimental Physics, Engineering Mechanics 1+2
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The students are competent to: • efficiently use engineering applications through a comprehensive understanding of the problems and fundamentals of computer science, and expertly guide their development • apply the basic principles of higher• level programming languages and software development to solve complex engineering problems • independently design algorithmic solutions to simple engineering problems and implement them in a higher level programming language • apply knowledge of software development in advanced courses
Content of the module	1. Basics of computer science for engineers and programming languages 2. Functions and flow structures 3. Object-oriented software development 4. Efficient data structures 5. Algorithms 6. Signals and images 7. Applications: e.g. numerics, statistics, differential equations
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: oral examination. Laboratory practical course: Lab work completion (SL). In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminars (4.5 SHW) Blackboard, beamer, PC, lecture, exercises Laboratory practical (1.5 SHW)

Literature	In the current issue: • Stein: Programmieren mit MATLAB, Hanser • Stein: Objektorientierte Programmierung mit MATLAB, Hanser • Weigend: Python 3 - Lernen und professionell anwenden, mitp • Gumm, Sommer: Einführung in die Informatik, Oldenbourg • Herold, Lurz, Wohlrab: Grundlagen der Informatik, Pearson

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Bachelor Thesis with Colloquium** **Bachelorarbeit mit Kolloquium**
Module number	BACAP-E
Module coordinator/ person responsible	Herr Prof. Dr. Enno Stöver
Duration of the module/ semester/ frequency	1 Semester/ 7th semester/ Every semester
Credits (CP)/ semester hours per week (SHW)	15 LP/ 0.00 SWS
Type of module , Applicability of the module	Mandatory module
Workload	Contact hours: 0 h and Self-study: 450 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	The Bachelor thesis can be registered, once all modules of the first three semesters have been completed and at least 170 credit points have been successfully earned.
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.

Competencies gained/ Learning Outcome	The Bachelor's Thesis is a scientific dissertation in written form. In the Bachelor Thesis, students demonstrate that on their own they are able to solve a problem of the degree program from a scientific, application-oriented or professional view point by applying scientific methods and findings, and that they are able to place that problem within its interdisciplinary context. The Bachelor Thesis serves to further develop and deepen the acquired skills of the overall degree program. The students are required to solve a complex problem from the wider field of mechanical engineering or manufacturing and to and document it according to scientific standards. The processing usually takes place in the following phases: - Familiarization with the subject matter and with the current state of technology/research. - Familiarization with/selection of methods and techniques for solving the problem. - Development of a solution concept. - Implementation/realization of own concept/approach. - Validation and evaluation of the results. - Presentation of the results in written form. - Colloquium consisting of a presentation followed by a discussion. Qualification goals in detail: -Integration into and independent processing of a complex task. task. - Independent application of theoretical and methodological knowledge. - Deepening of the problem solving competence as well as the competence of the theory and methodological knowledge in the application areas being worked on. - The students are to understand the boundary conditions, which the state of the art and the legal regulations, norms and standards, have on the solution of the the task at hand. - Presentation, evaluation and discussion of the solution approaches to the topic of the bachelor thesis in written form and as a presentation with discussion. - Consideration of environmental protection requirements and sustainability of solutions. - Processing of tasks with interdisciplinary character. - Derivation of the structure and the necessary processing steps. - Recognition and definition of interfaces in the processing of interdisciplinary tasks. - Evaluation and assessment of the engineering-technical solution as well as an economic consideration of the result.
Content of the module	In the Bachelor's thesis, an individual task is worked on according to the learning objectives in coordination between a professor and a company or a task is worked on as part of the project work at the university. The task is always determined by a professor of the university.
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Bachelor thesis (BA) (PL): Written paper (WP) for 12CP) and colloquium (CO) with presentation and oral examination for 3 CP (PL)
Learning and teaching types/ methods/ media types	In the Bachelor Thesis, an individual task is worked on according to the learning objectives in coordination between a professor and a company or a task is worked on as part of the project work at the university. The task is always determined by a professor of the university.

Literature	In the current issue: Lindsay, D.: Scientific writing: Thinking in words (No. 651.7 LINs). CSIRO Pub. Glasman-Deal, H.: Science research writing for non-native speakers of English. World Scientific. Potochnik, A., Colombo, M., & Wright, C.: Recipes for science: an introduction to scientific methods and reasoning. Routledge. Galvan, J. L., & Galvan, M. C.: Writing literature reviews: A guide for students of the social and behavioural sciences. Taylor & Francis.

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Cost Accounting** **Kostenrechnung**
Module number	KOR-E
Module coordinator/ person responsible	Herr Prof. Dr. Henner Gärtner
Duration of the module/ semester/ frequency	1 Semester/ 2nd semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	3 LP/ 3.00 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 51 h and Self-study: 39 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	Recommended: Industrial Management
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The module Cost Accounting is intended to familiarize the students with the objectives, basic concepts and tasks of cost accounting. The students should understand the system of cost accounting with the subareas of cost element accounting, cost center accounting, cost unit accounting and the differentiation of partial cost accounting, full cost accounting and the various different costing methods and learn how to apply them. This knowledge is indispensable for successful participation in projects and competent communication with the relevant departments in the company. companies.
Content of the module	The module contains the following main topics: • Basics of cost accounting, cost terms, liquidity • External and internal accounting, annual financial statements, cost and activity accounting • Cost type accounting: personnel, material costs, machine wear and tear • Cost center accounting: tasks, formation of cost centers, BAB • Cost unit accounting: calculation of prices, overhead calculation • Contribution margin accounting: profit optimization, marginal cost calculation • Machine hourly rate calculation • Flexible budgeting: budgeting, variance analysis • Short-term decision calculations (product selection, additional order, optimal production program, process selection)
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: Oral examination, Take-Home-examination. If there is more than one possible form of examination in the module, the responsible lecturer will announce the form of examination to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminars (3 SHW) Lecture with a large proportion of exercises, practical examples

Literature	in current edition: • Horngren, C./Datar, S./Rajan, M.: Cost Accounting. A Managerial Emphasis (Global Edition), Pearson • Schmolke, Deitermann: Industrielles Rechnungswesen IKR. Bildungshaus Schulbuchverlag • Schmolke, Deitermann: Industrielles Rechnungswesen IKR – Übungen zur Kosten- und Leistungsrechnung. Bildungshaus Schulbuchverlag

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Cyber Physical Production Systems** **Vernetzte Produktion und Produktionsautomatisierung**
Module number	VPPA-E
Module coordinator/ person responsible	Herr Prof. Dr. Alexander Koch
Duration of the module/ semester/ frequency	1 Semester/ 4th, 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards.
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	Students will be able to plan and optimize fully automated and digitalized factory processes within a cyber physical production system considering given process and technological requirements as well as from a economic and environmental/sustainability perspective.
Content of the module	• Motivation and goals for cyber physical production system • Digitisation of factory processes and development of digital twins • Autonomous production process planning and digital continuity from design to production • Machine to machine communication • Analysis of machine and process data, e.g. with artificial intelligence methods • Data-driven optimisation of manufacturing processes • Optimization of production resources (energy, material, waste) • Modern human-machine interfaces and digital assistance systems • Automation of production and logistics processes • Modularisation and flexibilization of automated processes • Application of industrial robots and autonomous vehicles in production • Programming of machines and robots
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Project (PL). Other possible forms of examination: Portfolio examination or written examination Laboratory practical course: Lab work completion (SL) In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-style teaching (3 SHW) (digital presentation, blackboard writing), group work Laboratory practical course (1 SHW): Laboratory with independent experimentation and laboratory report Self-study

Literature	Lecture notes will be provided in digital format. Supplementary literature in current edition: • Kanta Pal, Surjya et al.: Digital Twin – Fundamental Concepts to Applications in Advanced Manufacturing • Lüder, Arndt et al.: Multi-Disciplinary Engineering for Cyber-Physical Production Systems • Jeschke, Sabina et al.: Industrial Internet of Things – Cyber-manufacturing Systems • Wang, Lihui et al.: Cloud-Based Cyber-Physical Systems in Manufacturing • Misic, Jelena et al.: Machine-To-Machine Communications - Architectures, Technology, Standards, and Applications • Irwin, J. David: Industrial Communication Systems • Mahnke, Wolfgang et al.: OPC Unified Architecture • Finlay, Janet: An Introduction To Artificial Intelligence • Hofmann, Max: Smart Agents for the Industry 4.0 - Enabling Machine Learning in Industrial Production • Tracht, Kirsten: Robotics and Automated Production Lines

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Electrical Drives** **Elektrische Antriebstechnik**
Module number	EAT-E
Module coordinator/ person responsible	Herr Prof. Dr. Christian Rudolph
Duration of the module/ semester/ frequency	1 Semester/ 4th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 5.00 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 85 h and Self-study: 65 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards.
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The student will be able to calculate the steady-state operating behavior of electrical machines in motor and generator operation, as well as examine the operation of basic electronic circuits of drive technology by using the methods of the fundamentals of electrical engineering to penetrate design principles of electrical machines, develop equivalent circuit models, and analyze power electronic circuits in order to evaluate and utilize the diverse possibilities of electrical drives in mechanical engineering practice.
Content of the module	To achieve the study objectives, general electromechanical conversion processes are also discussed with regard to the design of magnetic circuits as well as the force generation mechanisms. This is followed by the introduction of the direct current machine in its particular constructive variants. The consideration of the common features of three-phase machines - rotating or traveling waves and the construction of their stator windings - at first leads to the asynchronous machine with its simpler construction, before the synchronous machine is discussed in a subsequent section. Finally, there is a treatment of electronics with a special focus on power electronic circuits of electrical drive technology. In the associated laboratory practical course, the steady-state operating behavior of DC and AC machines is primarily investigated on test bench setups. Both mains supply and converter supply are used, with special attention being paid to the measurement of mechanical and electrical quantities.
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: oral examination Laboratory practical course: Lab work completion (SL) In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the term.
Learning and teaching types/ methods/ media types	Seminar-style teaching (3.5 SHW), Blackboard and slides, presentations, class discussion in small groups, Laboratory practical course (1.5 SHW)

Literature	All course materials including a collection of exercises and laboratory script In current edition: • Boldea, I., Tutelea, L.: Electric Machines, Part I - Steady State, CRC Press, Boca Raton, USA • Binder, A.: Elektrische Maschinen und Antriebe, Springer-Verlag, Berlin, Heidelberg • Rashid, M. H.: Power electronics handbook, Butterworth-Heinemann, Burlington, MA, USA • Mohan, N., Undeland, T. M., Robbins, W. P.: Power Electronics, Wiley, Hoboken, NJ, USA

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Electrical Engineering Fundamentals** **Grundlagen Elektrotechnik**
Module number	GET-E
Module coordinator/ person responsible	Herr Prof. Dr. Christian Rudolph
Duration of the module/ semester/ frequency	1 Semester/ 3rd semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	4 LP/ 3.00 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 51 h and Self-study: 69 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	Recommended: Mathematics 1, 2
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The student is able to analyze selected problems and issues in direct current circuit analysis, static electric and magnetic fields, electromotive force, alternating current theory and electrical measurement technology using working and calculation methods of the subject in order to apply electrical engineering as a cross-sectional technology in mechanical engineering.
Content of the module	To achieve the study objectives, the electrophysical phenomena are first discussed with regard to the methodical use of knowledge in technical applications. For a better understanding of the students, special attention is paid to the systematic comparability of physical quantities of the different energy systems. Topics: Direct current (fundamentals, basic laws, direct current circuits), electric field, magnetic field, alternating current (basic laws, alternating current circuits, three-phase current, transformers), protective measures in electrical systems, electrical measurement technology. In the associated laboratory practical course, selected topics are studied in greater depth. Practical work on experimental setups and test benches enables students to record values and characteristics and compare them with theoretical findings. Students are familiarized with the operation of higher voltages and currents as well as typical measuring instruments. Necessary safety measures are implemented directly.
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: oral examination. In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-style teaching (3 SHW), blackboard and slides, presentations

Literature	All course materials including a collection of exercises and laboratory script In the current edition: • Hacker, V., Sumereder, C.: Electrical Engineering (Fundamentals), Verlag Walter de Gruyter, Berlin/Boston, 2020; • Feynman, R.P., Leighton, R.B., Sands, M.: Feynman Lectures on Physics, Vol. II, https://www.feynmanlectures.caltech.edu, 2023 • Pregla, R.: Grundlagen der Elektrotechnik, Hüthig Verlag, Heidelberg • Lindner, H., Brauer, H., Lehmann, C. et. al.: Taschenbuch der Elektrotechnik und Elektronik, Fachbuchverlag Leipzig im C. Hanser Verlag, München

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Energy from Biomass** **Energetische Nutzung nachwachsender Rohstoffe**
Module number	ENNR-E
Module coordinator/ person responsible	Herr Prof. Dr. Jan Piatek
Duration of the module/ semester/ frequency	1 Semester/ 4th, 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards.
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	• The students acquire the ability to assess the potential contribution of renewable raw materials to the energy supply from a technical and economic point of view. • The students know processes for thermal utilization, gasification or pyrolysis of renewable raw materials as well as processes for vegetable oil production, ethanol production and biogas production. • The students are able to plan, operate and optimize plants for the energetic use of renewable raw materials.
Content of the module	The students are able to assess the ecological and societal benefits as well as the ecological and societal problems of a use and, if necessary, to investigate partial aspects also with quantitative methods.
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Portfolio examination (PL) Other possible forms of examination: Oral examination Laboratory practical: Lab work completion (SL) In case of more than one possible form of examination in the module, the responsible lecturer will announce the form of examination to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-based teaching (3 SHW), Laboratory practical course (1 SHW), blackboard and slides, presentation
Literature	In current edition: • Kaltschmitt, Martin (ed.): Energy from Organic Materials (Biomass). Springer New York • Srivastava, Manish; Srivastava, Neha; Singh, Rajeev (eds.): Bioenergy Research: Biomass Waste to Energy. Nature Singapore Pte Ltd. • Koonaphapdeelert, Sirichai; Aggarangsi, Pruk; Moran, James: Biomethane: Production and Applications. Springer Singapore • De Blasio, Cataldo: Fundamentals of Biofuels Engineering and Technology. Springer Nature Switzerland AG • Treiche, Helen; Fongaro, Gislaine (eds.): Improving Biogas Production - Technological Challenges, Alternative Sources, Future Developments. Springer Nature Switzerland AG

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Engineering Mechanics 1** **Technische Mechanik 1**
Module number	TM-1-E
Module coordinator/ person responsible	Herr Prof. Dr. Thomas Grätsch
Duration of the module/ semester/ frequency	1 Semester/ 1st semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	4 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 68 h and Self-study: 52 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	Recommended: Bridge course in mathematics, in-depth knowledge of physics, mathematics, practical understanding of technical relationships.
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	After successfully completing this course the students are able to: • Develop free-body diagrams for any statically determined system of forces in two and three dimensions and to analyze reaction and coupling forces. • Understand and use the general ideas of internal forces and draw internal force and moment diagrams. • Calculate center of gravity, centroids, and moments of inertia. Social skills: In seminar discussions, the students will be motivated to discuss technical problems. For the completion of their homework assignments, the students are encouraged to cooperate within small groups. In addition, a tutorial is offered in which tasks for individual preparation are given and discussed.
Content of the module	1. Basic concepts and skills that form the foundation for structural and mechanical design as statics of rigid bodies, concept of forces, and free-body diagrams. 2. System of central forces, equilibrium in two and three dimensions, resultant forces. 3. General system of forces, pair of forces and moment, equilibrium in two and three dimensions, analysis of reaction forces. 4. Center of gravity (bodies, surfaces, lines) and moments of inertia for plane cross-sections. 5. Systems of rigid bodies with joints, free-body diagram, analysis of reaction forces and coupling forces at joints 6. Two dimensional trusses, nodal point method, Ritter’s method 7. Analysis of inner forces for two and three dimensional beams and frames, differential equations of inner forces, diagrams of inner forces and moments 8. Basic principles of friction, Coulomb's law, cable friction 9. Work and energy, principle of virtual work, analysis of reaction forces

Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: oral examination, portfolio examination. If there is more than one possible form of examination in the module, the responsible lecturer will announce the form of examination to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-style teaching (4 SHW), blackboard, computer/ beamer for illustrations, practical examples and calculations (e.g. with Matlab), demonstration experiments
Literature	In the current edition: • Gross, Hauger, Schröder, Wall, Engineering Mechanics 1: Statik, Springer • Hibbeler, Engineering Mechancis: Statics, Pearson • Dankert, Dankert, Technische Mechanik, Springer • Wriggers et al., Technische Mechanik kompakt, Teubner • Brommundt, Sachs, Sachau: Technische Mechanik: Eine Einführung, Oldenbourg

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Engineering Mechanics 2** **Technische Mechanik 2**
Module number	TM-2-E
Module coordinator/ person responsible	Herr Prof. Dr. Thomas Grätsch
Duration of the module/ semester/ frequency	1 Semester/ 2nd semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	Recomended: Engineering Mechanics 1
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	After successfully completing this course the students are able to: • calculate stresses and deformations of bars and beams in tension/compression, torsion, and for two and three dimensional bending. • define three dimensional stress and strain tensors, analyze plane stress and strain problems with analytical and graphical methods such as Mohr's circle, calculate equivalent stresses for arbitrary loading of beams. • evaluate the problem of buckling for individual components in structures and calculate buckling loads of beams. Social skills: In seminar discussions, the students will be motivated to discuss technical problems. For the completion of their homework assignments, the students are encouraged to cooperate within small groups. In addition, a tutorial is offered in which tasks for individual preparation are given and discussed.
Content of the module	1. Basic concepts: Rigid bodies, solids, deformation, stress and strain. 2. Bars: Deformation, stress and strain (including thermal expansion) when subjected to tension and compression 3. Stress and strain state: Stress tensor, strain tensor, generalized Hooke's law, principal stresses and directions, maximum shear stresses, strength hypotheses and equivalent stresses, plane stress state, Mohr's circle 4. Beams: Bending stresses, differential equation of bending line (Bernoulli theory), influence of shear forces (shear stresses and shear bending), calculation of bending curve and reaction forces statically indeterminate beams, especially by means of superposition from bending tables, two dimensional bending, inertia tensor, principal directions 5. Torsion of thin-walled profiles: Shear flow, Bredt's formulas, maximum stress, closed and open cross-sections. 6. Buckling of beams: Euler buckling, critical load, critical stress. 7. Deformations of trusses and frames: Deformation energy, work theorem and principle of virtual work, calculation of reaction forces in statically indeterminate systems.

Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: oral examination, portfolio examination. If there is more than one possible form of examination in the module, the responsible lecturer will announce the form of examination to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-style class (3 SHW), Exercises (1 SHW) Blackboard, computer/ beamer for illustrations, practical examples and calculations (e.g. with Matlab, FEM), demonstration experiments
Literature	In the current edition: • Gross, Hauger, Schröder, Wall, Engineering Mechanics 2: Mechanics of Materials, Springer • Hibbeler, Engineering Mechanics, Pearson • Dankert, Dankert, Technische Mechanik, Springer • Wriggers et al, Technische Mechanik kompakt, Teubner • Brommundt, Sachs, Sachau: Technische Mechanik: Eine Einführung, Oldenbourg

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Engineering Mechanics 3** **Technische Mechanik 3**
Module number	TM-3-E
Module coordinator/ person responsible	Herr Prof. Dr. Ulf Teschke
Duration of the module/ semester/ frequency	1 Semester/ 3rd semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	Recomended: Engineering Mechanics 1, Mathematics 1+2, Experimental Physics
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The students can: • calculate the stresses and deformations in or of members and beams for loading in tension/compression, torsion, and plane and spatial bending. • define the spatial stress and distortion tensors, analyze plane stress and distortion conditions using computational and graphical methods (e.g., Mohr's stress circle), and calculate equivalent stress for combined loading of beams. • recognize the risk of buckling of individual components in structures and calculate buckling loads of beams. Through the teaching form of seminar-based instruction, students are encouraged to discuss technical problems. The theoretical subject matter is illustrated by applied tasks, which are solved by the participants in advance and presented in the exercises. In addition, a tutorial is offered in which tasks for independent preparation are set and discussed. Students are motivated to form study groups to review the theoretical material and solve exercises.

Content of the module	The subject of the module is the statics of solids with the following contents: 1. Basic concepts: rigid bodies, solids, deformation, stress and strain or distortion. 2. Bars: deformation, stress and strain (incl. thermal expansion) when subjected to tension and compression 3. Stress and distortion state: stress tensor, distortion tensor, generalized Hooke's law, principal stresses and directions, maximum shear stresses, strength hypotheses and equivalent stresses, plane stress state: transformation and Mohr's stress circle 4. Beams: bending stresses, differential equation of the bending line (Bernoulli theory), influence of the shear force (shear stress and shear soft bending), determination of bending line and bearing reactions on statically indeterminate beams, especially by means of superposition from bending table, oblique bending, inertia tensor, principal directions, composite stresses 5. Torsion of thin-walled profiles: Shear flow, Bredt's formulas, maximum stress, closed and open sections. 6. Buckling of members: Euler buckling cases, critical load, critical stress 7. Deformations of trusses and frames: Deformation energy, work theorem and principle of virtual work, determination of bearing reactions in statically indeterminate systems.
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: oral examination, portfolio examination. If there is more than one possible form of examination in the module, the responsible lecturer will announce the form of examination to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-style teaching blackboard, computer/ beamer for illustrations, practical examples and calculations (e.g. with Matlab, FEM), demonstration experiments
Literature	In the current edition: • Gross, Hauger, Schröder, Wall: Technische Mechanik 3, Springer Verlag, Berlin • Gross, Ehlers, Wriggers: Formeln und Aufgaben zur Technischen Mechanik 3, Springer Verlag • Hibbeler, Technische Mechanik 3, Pearson Studium (Original: Engineering Mechanics) • Dankert, Dankert: Technische Mechanik, Springer Verlag, • Wriggers u.a.: Technische Mechanik kompakt, Teubner Verlag • Brommundt, Sachs, Sachau: Technische Mechanik - Eine Einführung. Oldenbourg Verlag

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Experimental Physics** **Experimentalphysik**
Module number	EPH-E
Module coordinator/ person responsible	Herr Prof. Dr. Marcus Wolff
Duration of the module/ semester/ frequency	2 Semester/ 1st and 2nd semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	6 LP/ 6.00 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 102 h and Self-study: 78 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	-
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	Technical-content and methodological competencies: Students will be able to: • Understand basic physical phenomena. • Explain basic physical principles and apply them to various technical problems. • Apply elementary experimentation and measurement techniques. • Document experiments in an engineering manner. • Evaluate and record measurement data appropriately. • Evaluate results on the basis of an error analysis. • Recognize cross connections between different physical fields. Social and self-competencies: • Time management • Learning and working techniques • Ability to work in a team • Communication skills.

Content of the module	Seminar teaching: • Basics of vector, differential and integral calculus • Mechanics (velocity, acceleration, circular motion, force, mass, Newton's axioms, torque, moment of inertia, work, energy, conservation of energy, power, momentum, conservation of momentum, angular momentum, conservation of angular momentum, motion of rigid bodies) • Oscillations and waves (free and forced oscillations, wave propagation, interference, diffraction, sound propagation) • Acoustics (sound pressure, sound level, sound insulation) • Geometrical optics (law of reflection, law of refraction, total reflection, dispersion, lenses, eye, optical instruments) • Wave optics (coherence, interference on thin films, light diffraction at slit and optical grating, polarization) • Quantum physics (thermal radiation, wave-particle duality, light quanta, photoelectric effect, Compton effect, matter waves) • Atoms (structure, spectral lines, laser) Laboratory Practical: Laboratory experiments from the above areas are performed in groups of two. The preparation of laboratory protocols, the engineering presentation of measurement results and the application of error calculation with error propagation law are taught and practiced.
Requirements for the award of credit points (Study and exam requirements)	Regular examination form for the module examination: Lecture: Written examination (PL) Laboratory: Lab work completion (SL)
Learning and teaching types/ methods/ media types	Seminar-style class (4.5 SHW) • Blackboard and computer presentation • Demonstration experiments Laboratory practical course: (1,5 SHW) • Self-study • Individual and group work
Literature	In the current edition: • B. Baumann, Physik für Ingenieure - Bachelor Basics, Edition Harri Deutsch, Europa-Verlag • H. Kuchling, Taschenbuch der Physik, Hanser Fachbuch • Experiment Instructions of HAW Hamburg, Dpt. M+P, Heinrich-Blasius-Institute

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Finite Element Method** **Finite-Elemente-Methode**
Module number	FEM-E
Module coordinator/ person responsible	Herr Prof. Dr. Thomas Grätsch
Duration of the module/ semester/ frequency	1 Semester/ 4th, 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	If examination or study achievements of the 1st semester are missing, no examination achievements can be taken from the 4th semester onwards. Recommended: Engineering Mechanics 1-3, Mathematics, Physics (not part of this programme: Numerical Methods of Mechanics)
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	Technical and methodology skills: The aim is to enable the students/participants to work independently with finite element standard software and to critically evaluate the calculated results. In the lectures, basic mechanical principles of the finite element method and its programming implementation will be taught. According to the specifics of mechanical engineering, in the lectures it will be focused on mechanics of materials, thermal elasticity, modeling aspects and dynamic analysis. In seminar discussions, foundations of engineering mechanics and numerical methods will be repeated and enhanced. Selected topics of advanced engineering mechanics are taught. Laboratory assignments are divided into two parts. In the first part, simple finite element models need to be programmed with a suitable software (e.g. in Matlab, Mathcad). In the second part, more advanced finite element analysis tasks will be carried out using commercial finite element systems (e.g. Ansys, Adina or MSC/Nastran). Social skills: In seminar discussions, the students/participants will be motivated to discuss technical problems. In the laboratory work, the students/participants will be encouraged and enabled to work self-dependently and autonomously through special training materials as well as the introduction to the documentation of the used program tools. For the completion of their laboratory and homework assignments, the students are encouraged to cooperate within small groups. Selected topics will be provided for assignments and the results will be presented during the lecture.

Content of the module	1. Introduction and motivation: Industrial applications of the finite element method, three steps of an analysis: pre-processing, solution, post-processing 2. Truss elements: basic differential equations, strong and weak form of differential equations, local stiffness matrix and matrix assembly, principle of virtual displacements, shape functions, higher-order elements, local-global transformations, finite element analysis of trusses 3. Beam elements: basic differential equations, stresses and strains, principle of virtual displacements, local stiffness matrix and matrix assembly, three-dimensional beam elements, local coordinate systems, local-global transformations, equivalent load vector 4. Modeling aspects: modeling of supports and hinges (single point and multiple point constraints, rigid body elements), assessment of finite element solutions, practical guideline to assess and assure model and mesh quality, treatment of singularities 5. Shell, plate, and slab elements (thin-walled structures): approximation on two-dimensional element domains, linear shape functions, higher-order shape functions, isoparametric elements, local-global coordinate transformations, classification and analytical treatment of thin-walled structures, plane stress state, plane strain state, kinematics of plate bending elements, local stiffness matrix and matrix assembly, non-conforming plate bending elements, mixed methods for shell elements 6. Three-dimensional elements: approximation on three-dimensional element domains, linear shape functions, higher-order shape functions, displacements and strains, three-dimensional stress state and equilibrium, linear elasticity, brick elements and tetrahedrals 7. Finite elements in structural dynamics: vibrations of mass-spring-systems, stiffness matrix and mass matrix, eigenmodes and eigenfrequencies, forced vibrations, mass matrices for trusses and beams 8. Summary and outlook: linear and nonlinear analysis, super-elements, thermo-elastic analysis, fluid-structure-interactions and multi-physics, error analysis
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: Oral examination or Portfolio examination Laboratory practical course: Lab work completion (SL) In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-style teaching (3 SWH), blackboard, computer/ beamer for illustrations, practical examples and calculations (e.g. with Matlab, FE standard software), individual supervision in the laboratory (1 SWH)
Literature	In current edition: • Bathe: Finite Element Procedures, Watertown • Link: Finite Elemente in der Statik und Dynamik, Springer • Steinke: Finite-Elemente-Methode, Springer • Fish and Belytschko: A First Course in Finite Elements, J. Wiley

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Fluid Mechanics 1** **Strömungslehre 1**
Module number	STL-1-E
Module coordinator/ person responsible	Herr Prof. Dr. Jan Piatek
Duration of the module/ semester/ frequency	1 Semester/ 3rd semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	3 LP/ 2.50 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 43 h and Self-study: 47 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	-
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The students are able to: • grasp and apply the basic laws and principles of fluid mechanics. • determine forces in stagnant liquids and gases. • apply the energy theorem or Bernoulli's equation to simple flow problems. • distinguish between frictionless and frictional flow. • distinguish between incompressible and compressible flows. • calculate frictional pipe flows for simple cases. The aim of the lecture is to learn the methods of dealing with problems in fluid mechanics and which possible solutions are available. In laboratory experiments, parts of the lecture are investigated. The handling of test rigs, the evaluation of measured values and the documentation of experiments are practiced exemplarily.
Content of the module	Hydrostatics, calculation of forces on surfaces Structure of the atmosphere, basic law of aerostatics, description of flows, one-dimensional streamline theory, continuity equation, energy theorem and Bernoulli equation, 2nd law, concept of dissipation, examples of frictionless flows, introduction to frictional flows, overview Frictional tube flow, mass and volume flow measurement.
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: oral examination Laboratory practical course: Lab work completion (SL) In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-style teaching (2 SHW) Laboratory practical course (0.5 SHW) Self-study, exercises blackboard, slides, PPT / beamer, software

Literature	In the current edition: • Klaus Gersten: Einführung in die Strömungsmechanik. Vieweg-Verlag, Braunschweig, Wiesbaden • Bruno Eck: Technische Strömungslehre. Band 1: Grundlagen, Springer-Verlag Berlin Heidelberg New York London Paris Tokyo • Bruno Eck: Technische Strömungslehre. Band 2: Anwendungen, Springer-Verlag Berlin Heidelberg New York London Paris Tokyo • I. E. Idel'chik: Handbook of Hydraulic Resistance. Springer-Verlag

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**German Language Integrationsfach**
Module number	IF-ALG-E
Module coordinator/ person responsible	Herr Prof. Dr. Enno Stöver
Duration of the module/ semester/ frequency	1 Semester/ 4th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	4 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 68 h and Self-study: 52 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	All levels accepted – different courses available
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The students • have improved the ability to communicate in German to assist in their daily interaction with their surroundings, but also to express themselves efficiently and competently in their course studies, • are better prepared to participate in technical discussions for the purpose of an internship or a career in a German company, • have used authentic teaching material which improved their speaking, writing, reading and understanding abilities, • have acquired grammatical proficiency and broadened their understanding of the German culture, • have trained their optimization of presentations.
Content of the module	German language classes are offered on different levels, for example elementary (A1), pre-intermediate (A2-B1), intermediate (B2), or upper intermediate (C1-C2) according to CEFR (Common European Framework of Reference for Languages) • Grammar, syntax, vocabulary and practical speech training for daily professional and technical situations • Analysis, presentation and documentation (description) of technical and daily situations in German • an excursion to one of the Hamburg companies, which is a linguistic as well as technical challenge, upon which we will later reflect and comment on
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Portfolio exmination (SL). Other possible forms of examination: Presentation, Written Exam, Oral Exam, Written Presentation, Project. In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-style teaching (4 SHW) Successful paper presentation on the basis of written preparation (Pres) (SL)

Literature	List of work and reference books will be provided Internet links, bilingual dictionary, handouts

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Industrial Internship** **Hauptpraktikum**
Module number	BPP-E
Module coordinator/ person responsible	Herr Prof. Dr. Enno Stöver
Duration of the module/ semester/ frequency	1 Semester/ 7th semester/ Every semester
Credits (CP)/ semester hours per week (SHW)	15 LP/ 1.50 SWS
Type of module , Applicability of the module	Mandatory module
Workload	Contact hours: 26 h and Self-study: 424 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	If 1st, 2nd and 3rd semester graded (PL) or non-graded (SL) parts of a module exam are missing, the internship shall not be started.
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	Technical, content-related and methodological competencies: • In accordance with one's own profile building, the specialized knowledge is primarily deepened through self-study, teamwork is practiced and strengthened. • The students apply the technical and social competences acquired during their studies and during their internship and learn the requirements that are placed on an engineer in a company. • The students are able to evaluate the complex interrelationships in industrial tasks and apply their acquired technical knowledge and problem•solving methods to solve these tasks. • The students learn about the structures, processes and organization in an company and evaluate how their tasks fit into the research, development and project work of the company. • The students grasp the boundary conditions which norms, standards and state of the art regulations have on the solution of their tasks. Social and personal competence: • Creating tasks with an interdisciplinary character; coordinating work packages within the framework of the given assignment; leadership and guidance within the team; recognizing and defining interfaces while coping interdisciplinary tasks; evaluating and assessing the engineered solution as well as considerating the result from an economic viewpoint; students are able to integrate employees from other disciplines into the solution. • The students recognize the value system and its underlying rules of cooperation in a company and they learn to evaluate its influence on the success of the company. • The students learn about the international interdependences of a company with the globalized world and can derive the resulting requirements to be applied on themselves. • The students recognize the necessity of team competencies and can assess their individual strengths and weaknesses in a professional environment.

Content of the module	Individual assignment according to the learning objectives in coordination between a professor and the company.
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Portfolio examination (SL) Details according to internship guidelines (Richtlinie zum Hauptpraktikum)
Learning and teaching types/ methods/ media types	Industrial Internship
Literature	-

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Industrial Management** **Industriebetriebslehre**
Module number	IBL-E
Module coordinator/ person responsible	Herr Prof. Dr. Henner Gärtner
Duration of the module/ semester/ frequency	1 Semester/ 1st semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	3 LP/ 3.00 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 51 h and Self-study: 39 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	-
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The module Industrial Management (IBL) provides students with condensed knowledge of the essential business interrelationships for successfully managming operational processes in industrial and service companies. Acquring such knowledge of the entrepreneurial processes, their interaction and the responsibilities of the specific organizational units enables the students for their own ideal career positioning as well as for professionally cooperating between the various business divisions of such enterprieses.
Content of the module	The module includes the following main topics: • Goals and position of companies in the economic system • Strategic management and methods • Business organization, legal forms, human resources management • Procurement strategies and processes, materials management • Production program planning, control, location strategies • Logistics, warehouse management, material flows • Marketing strategies, market research, marketing mix, research and development, innovation processe
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: Oral examination, Take-Home-examination. If there is more than one possible form of examination in the module, the responsible lecturer will announce the form of examination to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminars (3 SHW) Digital presentation, practical examples, interactive group discussions, case studies, exercises

Literature	In current edition: • Hill, C. International Business. McGraw-Hill • Peng, M. W. Global business. Cengage Learning • Steers, R. M., Nardon, L., & Sanches-Runde, C. J. Management Across Cultures. Cambridge University Press • Olfert, K., Rahn, H.-J., Einführung in die Betriebswirtschaftslehre 8. Auflage, NWB Verlag • Thommen, J.-P., Achleitner, A.-K., Allgemeine Betriebswirtschaftslehre, 8. Auflage, Gabler, Wiesbaden Selected journal articles, cases, and institutional publications

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Introduction to Car Body Design** **Einführung in die Karosseriekonstruktion**
Module number	KK1-E
Module coordinator/ person responsible	Herr Prof. Dr. Alexander Piskun
Duration of the module/ semester/ frequency	1 Semester/ 4th, 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	Recommended: Students are already able to develop prismatic and cylindrical surfaces both manually (using methods of descriptive geometry) and using CAD tools. If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards.
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	Students • know the most important car body requirements (functional, legal and consumer-driven) • understand and can apply legal requirements in order to validate the car body design • know the basic car body modules / assemblies and their functions. • know automotive product development phases.
Content of the module	• Car body representation in the drawing • Specialties of the passenger car body parts in comparison to machine components in other industries • Overview of most important car body requirements • Application of representative legal requirements for design validation • Fundamentals of car body design; arts of car body structure (steel-stamping, monocoque and space frame), overview of important modules and assemblies (doors and closures, front structure, wiper systems, windshield etc.) • Dimensional variation in steel stampings and basic methods to design for preision • Design classes on car cabin development (different windshield / side part combinations, development of an A-Pillar accordingly to cross-sections specified etc.)
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination (PL): Written examination. Other possible forms of examination: Presentation, Written paper. Laboratory practical course: Lab work completion (SL) In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Interactive lectures with exercises

Literature	In the current edition: • Malen, Donald E.: Fundamentals of Automobile Body Structure Design, SAE International – Automobiles • Morello, Lorenzo et al.: The Automotive Body: Volume II: System Design, Springer – Technology & Engineering • Burandt, U.: Ergonomics for Styling and Design. Dr. Otto Schmidt • Piskun, Alexander: Car Body Development Scripts online • Further information from industry as lecture scripts from the teaching professor

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Introduction to Commercial Vehicle Design** **Grundlagen der Nutzfahrzeugkonstruktion**
Module number	NK1-E
Module coordinator/ person responsible	Herr Prof. Dr. Peter Seyfried
Duration of the module/ semester/ frequency	1 Semester/ 4th, 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	Recommended: Basic knowledge of engineering mechanics (statics and strength of materials), materials science (properties and processing of rolled steel) and machine elements (joining technology, in particular welding and strength of materials) is recommended. If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards.
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	Students will • know the commercial and legal requirements for commercial road vehicle concepts • be able to design a load optimized frame structure of a commercial road vehicle • know different variants of superstructures and auxiliary frames which are suitable for different types of freight • be able to develop concepts for load securing and load curves
Content of the module	Introduction and overview • Historical development • Road vehicles of today Conceptual Design of commercial vehicle frame structures • Standards and specifications • Choice of materials and semi-finished parts • Production and joining methods • Profile and node design • Load assumptions and calculations • Axle systems Load curves and load securing • Load and loading equipment • Legal requirements and testing procedures • Load curve calculation • Dynamic forces

Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination (PL): Written examination. Other possible forms of examination: Oral Exam, Written Paper. Laboratory practical course: Lab work completion (SL) In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Interactive lectures with exercises
Literature	Lecture Notes In the current edition: • Hoepke, Breuer (Hrsg.): Nutzfahrzeugtechnik. Springer Vieweg Verlag. • Manufacturers' guidelines for fitting bodies

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Introduction to Vehicle Dynamics Fahrwerk/Fahrverhalten**
Module number	FWF-E
Module coordinator/ person responsible	Herr Prof. Dr. Christian Wolfgang Fervers
Duration of the module/ semester/ frequency	1 Semester/ 4th, 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	Recommended: Knowledge in Engineering Mechanics 1 (statics) and 3 (dynamics). If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards.
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The students • will know basic termins in vehicle dynamics • will be able to put the basic effects of tires, handling and suspension into the right context. • will be able to judge about conflicting goals in the setup of vehicle suspension.
Content of the module	• Mechanical structure of an air filled tyre • Spring stiffness, damping and rolling resistance of tyres • Longitudinal slip, sideslip angle, pneumatic trail, camber • Basic ideas of rubber to road contact and force transmission • Basic diagrams to characterize tyre behaviour • Single-track (bicycle) model • Basic equations for driving behavior • Steering angle, yaw angle, side slip angle • Oversteer/understeer • Road holding, limit range, transition region • Yaw gain, critical speed, characteristic speed • Lateral load transfer, anti roll bar, camber, toe • Examples of electronic means to influence driving dynamics • Quarter-vehicle model • Basic equations of ride dynamics • Basic layout of springs and shock absorbers
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination (PL): Written examination. Other possible forms of examination: Oral examination, Written paper. Laboratory practical course: Lab work completion (SL) In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Interactive lectures

Literature	In the current edition: • Gillespie, T.: Fundamentals of Vehicle Dynamics. SAE International • Dixon, J. C.: Tires, Suspension, Handling. SAE International • Milliken, W. F. et al.: Race Car Vehicle Dynamics, SAE International • Zomotor, A.: Fahrwerktechnik, Fahrverhalten. Vogel Buchverlag, Würzburg • Heißing, Ersoy, Gies: Fahrwerkhandbuch, Vieweg • Mitschke, Wallentowitz: Dynamik der Kraftfahrzeuge, Springer

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Introductory Lab / Learn Project** **Einführungslabor / Lernprojekt**
Module number	ELPJ-E
Module coordinator/ person responsible	Herr Prof. Dr. Henner Gärtner
Duration of the module/ semester/ frequency	2 Semester/ 1st and 2nd semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	3 LP/ 2.00 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 34 h and Self-study: 56 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	-
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.

Competencies gained/ Learning Outcome	Overall learning outcome: The Learn Project is an essential component in the project-oriented form of teaching. Project-oriented teaching can also be found in various other modules throughout the study, e. g. during the Bachelor Project, the Study Research Paper or Design Work, and during the Bachelor Thesis. In doing so, we have adopted ideas from the Anglo-American MIT CDIO initiative, which is a fundamental innovation in engineering education according to the Conceive-Design-Implement-Optimize principle. Competency Objectives Introductory Lab 1st Semester: • The students' interest and awareness for problem solving in mechanical engineering shall be created and some mathematical and physical knowledge shall be applied. • While preparing and evaluating experiments, students should learn why there is a need for the basic lectures (mathematics etc.). • The students should be hands-on (theory is taught in other modules). • Students should be taught how to prepare a protocol. • Students should learn how to use measurement techniques. Competency goals Learn Project 2nd semester: The competence for the product-oriented application of the contents taught in the core study taught in the core curriculum. The focus is on: • Consolidate technical competencies • Promote knowledge in a sustainable way • Interdisciplinary understanding • Early dialog between students and industry Social and personal skills: • Learning the ability to work constructively in a group and in particular to take into account different prior knowledge, learning types. On the one hand, this promotes the intrapersonal ability to assess one's own performance and limits, as well as the interpersonal ability to achieve something together with other people. • Indirectly, this also contributes to the social responsibility of the engineer in society.

Content of the module	Course contents Introductory laboratory 1st semester: • The specification of the various experiments and equipment shall lead the students to raise questions on data or boundary conditions which will be discussed and deepened scientifically in the further course of the study program. • Basic experiments from the field of development and construction • Basic experiments from the field of energy and plant systems as well as thermodynamics • Basic experiments from the field of production technology and production management • Elaboration of the experimental set-up and the experimental objectives on the basis of the description of the experiment • Recognition and implementation of the experimental objectives • Independent execution of the experiments • Evaluation of the experiments in the form of an experimental protocol • Presentation of the test results in an engineering manner Course contents Learning project 2nd semester: • Based on an industrial product or service, the students are to recognize the applicability of the basic knowledge of the engineering studies in an exemplary way and present it. • For this purpose, the teaching professor or industry representative will bring in a specific task or product rsp. a component. Over the course of the semester, the students will make references to basic lectures such as mathematics, physics, technical mechanics, design or industrial management. • Particular attention is paid to interdisciplinary topics. • The work is done in a team which should organize itself. During the presentation of the results of 20 minutes each team member must be involved. In addition to the technical statement, a presentation of the of the experience gained in terms of social competence must be included.
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Project (SL) Laboratory practical: Lab work completion (SL)
Learning and teaching types/ methods/ media types	Laboratory Experiments (1 SHW) , Self-study Project (1 SHW) Group work, field report, Powerpoint presentation via beamer
Literature	Laboratory Manual for Introductory Laboratory HAW Hamburg

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Joining Technology** **Fügetechnik**
Module number	FUEGET-E
Module coordinator/ person responsible	Herr Prof. Dr. Shahram Sheikhi
Duration of the module/ semester/ frequency	1 Semester/ 4th, 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards. Recommended: Materials Science, Machine Elements and Systems Design A+B, Electrical Engineering Fundamentals
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The students know the basic processes of joining technology (welding and related processes) and know how to assess the areas of application of the common processes and equipment. They have basic knowledge of the interactions of the welding suitability of the common materials, the welding safety of the constructively selected welded joints, the welding possibility of the processes and the welding faults derived from this. In addition to economic aspects, you will have gained insight into practical application examples as well as safety aspects. The students acquire fundamental knowledge that enables them to evaluate joining technology issues in design and production and to develop professional solutions.
Content of the module	Welding methods and equipment for - fusion welding • Press welding - Special welding processes • Thermal cutting - Design and calculation • Design principles - Butt types • Seam preparation, materials and their welding behavior • Basics of metallic materials - Alloy structure • Heat conduction - Filler materials and shielding gases • Welding fabrication - Work safety • Production methods - Defects and test methods • Brief outline of brazing, mechanical joining processes and bonding.
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: Oral Examination, Portfolio Examination. Laboratory practical course: Lab work completion (SL). In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-style teaching (3 SWH): PowerPoint presentation by beamer, blackboard Laboratory practical course (1 SWH): Demonstration of common joining processes Analysis and distance learning materials as well as own welding under supervision

Literature	In current edition: • Course documents for the International Welding Engineer • Die Metallurgie des Schweißens; Springer Verlag • Praxiswissen Schweißtechnik; Vieweg+Teubner-Verlag

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Machine Elements and Systems A** **Konstruktion A**
Module number	KONA-E
Module coordinator/ person responsible	Herr Prof. Dr. Frank Koppenhagen
Duration of the module/ semester/ frequency	1 Semester/ 2nd semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	6 LP/ 4.50 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 77 h and Self-study: 103 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	-
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	Building on the course Mechanical Drawing and CAD, students understand the structure and function of selected machine elements, such as axles and shafts, shaft-hub connections and deep groove ball bearings and their interaction in a mechanical engineering design. They will be able to design and calculate these machine elements and combine them in a targeted manner to fulfill their function in an assembly or overall mechanical engineering design. The students learn the basics of strength theory and can carry out a dynamic and static load capacity for shafts and axles according to DIN 743. The students understand the basic principles of force-flow and production-oriented design of components and machine elements and can confidently implement these in the creation of their own mechanical engineering designs. In the context of the design work, the independent solution of an engineering design task using scientific methods in individual or group work is taught.
Content of the module	Core contents: • Fundamentals of strength of materials • Function, design and required diameters of axles and shafts • Static and dynamic proof of load bearing capacity verification for axles and shafts according to DIN 743 • Structure, function and design of locating/locating bearing arrangements with deep groove ball bearings • Function, design and calculation of positive and nonpositive shaft-hub connections • Fundamentals of design, in particular force-flow optimised design and design for manufacturing • Lecture-accompanying, independent processing of a design task in individual or group work, preferably using CAD Optional contents: • Rivet, bolt and pin connections • Welded joints

Requirements for the award of credit points (Study and exam requirements)	Regular examination form for the module examination (PL): Written examination. Other possible forms of examination: Oral exam, Project. Construction and planning task (SL): Engineering design task. In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	• Seminar-based teaching (3 SHW) • Independent creation of a design work in individual or group work, preferably using CAD (1.5 SHW) • Tests with differentiated feedback on the design work • Calculations • Exercises • Self-study
Literature	Lecture Notes DIN 743: Calculation of load capacity of shafts and axles - Part 1-3

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Machine Elements and Systems B** **Konstruktion B**
Module number	KONB-E
Module coordinator/ person responsible	Herr Prof. Dr. Jan Holländer
Duration of the module/ semester/ frequency	1 Semester/ 3rd semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	6 LP/ 4.50 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 77 h and Self-study: 103 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	Recommended: Machine Drawing and CAD, Machine Elements and Systems A, and Engineering Mechanics 1 and 2
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	Students are able to assess independently, select, redevelop, improve, design and calculate essential machine elements. This will be done independently and in compliance with the applicable requirements. Students know that this involves taking into account the interaction of different neighboring systems with each other. For that, students can independently select, apply and, if necessary, further develop or create new suitable strategies for engineering design. Furthermore, the students are able to consider recycling-oriented design, ethical principles as well as basic aspects of sustainability during these activities. Project work, which is supervised and carried out in small groups, enables the students to organize project teams independently, to apply teamwork successfully, and to apply the knowledge gained in the seminar lectures independently and efficiently. The subject of these design tasks is a technical system consisting of several machine elements. Design drawings are to be created by using a CAD system.
Content of the module	Core contents of seminar-based instruction: • Bolted connections • Roller bearings • Slides bearings • Clutches and brakes Optional content of the seminar lecture: • Basics of tribology as welll as • Metal, rubber and gas springs Contents of project work: Independent creation of a design in a project team, accompanying the lecture
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination (PL): Written examination. Other possible forms of examination: Oral examination, Project. Construction and planning task (SL): Engineering design task. If there is more than one possible form of examination in the module, the responsible lecturer will announce the form of examination to be taken at the beginning of the course.

Learning and teaching types/ methods/ media types	Seminar-based teaching (3 SWS), Project work accompanying the lecture (1.5 SWS) Blackboard, slides, PPT and beamer, presentations, self-study, online lecture, asynchronous teaching. To support teaching, the laboratory for machine elements and tribology has, if required, a slide bearing test standand a bolt test stand. Using these facilities is only possible in small groups and with the supervision of teaching and/or laboratory staff.
Literature	Lecture Notes In the current edition: • Berthold Schlecht: Maschinenelemente 1 / 2. Pearson Studium, • Niemann/Winter/Höhn: Maschinenelemente 1 / 2. Springer Vieweg Verlag, 5. Auflage 2019 / Springer Verlag • Decker, Karl-Heinz: Maschinenelemente. Hanser Verlag • Wittel, Herbert (Hrsg.); Roloff/Matek, Maschinenelemente. Springer Vieweg • Steinhilper/Sauer: Konstruktionselemente des Maschinenbaus 1 / 2. Springer Vieweg • Haberhauer, Horst: Maschinenelemente. Springer Vieweg • Künne, Bernd (Hrsg.). Köhler/Rögnitz, Maschinenteile 1 / 2. Vieweg Teubner • DIN 743, Tragfähigkeitsberechnung von Achsen und Wellen, Teil 1 bis 3. Beuth Verlag • VDI-Richtlinie 2230, Blatt 1. Systematische Berechnung hochbeanspruchter Schraubenverbindungen - zylindrische Einschraubenverbindungen. VDI Düsseldorf

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Machine Elements and Systems C** **Konstruktion C**
Module number	KONC-E
Module coordinator/ person responsible	Herr Prof. Dr. Andreas Meyer-Eschenbach
Duration of the module/ semester/ frequency	1 Semester/ 4th, 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards. Recommended: Machine Elements and Systems A+B
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	Students are able to design more complex machine elements, gearboxes and machine systems according to functional, weight and cost and environmental aspects. The optimally coordinated interaction of a wide variety of machine elements and components is taken into account. The students know that gear units and machine systems must not only be optimized on their own, but that the entire process chain from task specification to product creation, use and disposal must be recognized and mastered.
Content of the module	Introduction and overview of mechanical drive trains and belt and chain drives, link chains and crank drives as well as friction gears. Overview of gears with different toothing geometries, in-depth study of involute toothing, profile shifts, design and recalculation of load capacity. Introduction and overview of spur gears, bevel gears, helical gears, worm gears, planetary gears, friction gears, chain and belt drives. Calculation and design of spur gears, planetary gears and other gears. Design of gearboxes and their housings in various designs, taking into account lubrication and sealing technology. Coordination and connection of multiple gearboxes to form a mechanical drive train. Optional: Overview of manual and stepless gearboxes, delivery and requirement characteristics. Linear drives. Semester-long laboratory exercises with experiments on gearboxes and tribological systems.
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: Oral examination. Laboratory practical course: Lab work completion (SL). In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-style teaching (3 SHW) with blackboard and beamer and teaching models Laboratory practical course (1 SHW), Experiments in the laboratory with teaching models and experimental equipment.

Literature	Lecture notes, labatory notes. In current edition: • Schlecht, B.: Maschinenelemente 2. Pearson Verlag • Niemann G., Winter H.; Höhn, B.-R.: Maschninenelemente Band 2 und 3. Springer Verlag • Roloff Matek: Maschinenelemente. Springer-Vieweg Verlag • Decker: Maschinenelemente • Haberhauer; Bodenstein: Maschinenelemente

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Machine Elements and Systems C Design Project FEHLT**
Module number	KONCH-E
Module coordinator/ person responsible	Herr Prof. Dr. Andreas Meyer-Eschenbach
Duration of the module/ semester/ frequency	1 Semester/ 4th, 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 1.50 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 26 h and Self-study: 124 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards. In order to have the compulsory elective module "Machine Elements and Systems C Design Work" recognised, "Machine Elements and Systems C" must also be taken. Recommended: Machine Elements and Systems A+B+C
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	Students are able to work on an advanced design task in a team. Advanced here means that complex machine elements such as drives and gear drives are used and integrated into a drive train or machine system. Alternatively, other comparable tasks can be set for machine systems that are integrated into the design process.
Content of the module	Project management in a team and division of tasks and assignment of responsibilities. Structuring the design task and planning the subtasks. Working on and solving the task, among other things, by applying the material taught in Design C. The main steps in this process are: • Design of a drive train with several gearboxes • Layout and rough design of gearboxes • Performing at least one more extensive calculation of a highly stressed component • Rough and fine design of at least one complex assembly (e.g. gearbox) • Fine-tuning of several assemblies • Optimizing at least one smaller assembly (e.g. a gear stage). • Checking interfaces and essential functions • Creating essential manufacturing documents • Merging of results • Presenting the team results several times with the aim to get an approval for further project work or finally to get an acknowledgement for the design work.
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Engineering Design Task (PL)

Learning and teaching types/ methods/ media types	Design and planning work (1.5 SHW), design meetings. Creation of a design work with the use of sketches, drawings and 3D modeling in a 3D CAD system as well as with conventional calculations and optimization calculations with calculation programs.
Literature	Lecture notes KONC-E Further literature see module "Machine Elements and Systems C"

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Manufacturing Technology** **Fertigungstechnik**
Module number	FTT-E
Module coordinator/ person responsible	Herr Prof. Dr. Dietmar Pähler
Duration of the module/ semester/ frequency	2 Semester/ 2nd and 3rd semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	6 LP/ 6.00 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 102 h and Self-study: 78 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	Recommended: Finished basic hands-on training (e.g. industrial internships).
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The students gain practice-oriented insights into selected important manufacturing processes, used for the industrial production of components, as well as the equipment used for these processes, e.g. machines, tools, supplies. The students understand the basic functional principles, the essential features, as well as the basic technical advantages and disadvantages of the covered manufacturing technologies and processes. The students will be able to derive first qualitative and/or quantitative statements about the relationships between the most important input and output variables, as characteristics of the various handled technologies. This will enable them to analyse the processes exemplarily, taking appropriately chosen technological, quality, environment and/or economic related criteria into consideration. Ultimately, the students will be able to identify principally suitable manufacturing processes for a specific manufacturing task. They will be abled to discuss basic process alternatives with designing engineers and production specialists from the design phase onwards, concerning e.g. manufacturing time, part quality, environment and cost related aspects.

Content of the module	Classroom teaching (2nd semester): 1. Introduction and overview: Systematics, classification system, terminology, first applications. 2. Exemplary processes - primary shaping: Principles of metall casting; selected casting processes; powder metallurgy; selected additive manufacturing processes. 3. Exemplary processes - forming: Systematics; basics such as stress states, deformation, strength, force, work; selected sheet metal and solid forming processes. 4. Exemplary processes - shearing/cutting: Process principles; stamping; fine blanking; selected example processes. 5. Exemplary processes - cutting with geometrically defined cutting edges: Engagement principles, important planes and angles; chip formation; cutting force/power; tool wear, tool lifetime; cutting tool materials; example processes. 6. Exemplary processes - cutting with geometrically undefined cutting edges: Process principles; process parameters; grain materials; tool types and bonding systems; tool preparation; example processes. Laboratory (3rd semester): The students deepen the class contents of the 2nd semester in laboratory sessions, with focus on known as well as new technological topics. They consolidate their understanding of the manufacturing processes. Based on their existing knowledge, the students can work out the respective investigation focus and plan the experimental procedures. The laboratory sessions are carried out in small groups of students under guidance of staff members. After the lab session, the students summarize the session by writing technical reports. In the lab sessions, experiments or demonstrations are offered, e.g. focussing on following topics: • Moulding: Vacuum casting, additive manufacturing, powder metallurgy • Forming: Deep drawing, upsetting, impact extrusion • Machining with geometrically defined cutting edges: Investigation of cutting force/tool wear during turning; presetting of tools; NC turning/milling process chain: process planning, tool selection, definition of process parameters, programming of the machine tools, production of workpieces by turning/milling • Ablation: Investigation of spark erosive countersinking processes • Metrology: Measurement of taper, roughness, material strength; 3D geometry scanning; 3D coordinate measuring technology • Selected additional topics
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: Oral examination. In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course. Laboratory practical course: Lab work completion (SL).
Learning and teaching types/ methods/ media types	Seminar-based teaching (4.5 SHW); Visual aids; blackboard; beamer for slides, pictures and films, sample parts Laboratory-based practical course (1.5 SHW): Various machines, measurement equipment

Literature	Scripts for the classes will be provided in digital format. Supplementary literature in current edition: • Campbell, J.: Complete Casting Handbook; Butterworth-Heinemann • Davim, J. P.: Modern Manufacturing Engineering; Springer • Gibson, I.; e.a.: Additive Manufacturing Technologies; Springer • Klocke, F.: Manufacturing Proceeses Vol. 1 - Cutting; Springer • Klocke, F.: Manufacturing Proceeses Vol. 2 - Grinding, Honing, Lapping; Springer • Klocke, F.: Manufacturing Proceeses Vol. 4 - Forming; Springer • Sahoo, M., e.a.: Principles of Metal Casting; McGraw-Hill, SME • Tönshoff, H. K.; Denkena, B.: Basics of Cutting and Abrasive Processes; Springer

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Materials Science** **Werkstoffkunde**
Module number	WSK-E
Module coordinator/ person responsible	Herr Prof. Dr. Gerhard Biallas
Duration of the module/ semester/ frequency	2 Semester/ 1st and 2nd semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	7 LP/ 7.00 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 119 h and Self-study: 91 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	-
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	Students can derive the fundamentally different properties of metallic and non-metallic materials from their atomic structure, bonding types and microstructure. They can specifically influence the mechanical properties of materials: Mechanisms that lead to high material strengths - quenching and tempering of steels, precipitation hardening of aluminum alloys, and reinforcing plastics with fibers, are the main focus here. Students will be able to practically apply typical material testing procedures on metals and plastics.
Content of the module	• Groups of materials • Atomic structure, bonding types • Fundamentals of metals science • Metals under load • Steels and cast irons • Heat treatment of steels • Aluminum materials • Heat treatment of aluminum alloys • Fundamentals of polymer science • Composite materials • Destructive materials testing • Non-destructive materials testing • Metallographic investigations
Requirements for the award of credit points (Study and exam requirements)	Regular examination form for the module examination: Written examination (PL). Other possible forms of examination: Oral examination, Take home examination. Laboratory practical course: Lab work completion (SL). In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-based teaching (5.5 SHW) Practical experiments in the laboratory (1.5 SHW)

Literature	In current edition: • J.F. Shackelford: Introduction to Materials Science for Engineers, Pearson Education • S. Kalpakjian, S.R. Schmid, E. Werner: Manufacturing Processes for Engineering Materials, Pearson Education • H.-J. Bargel, G. Schulze: Werkstoffkunde, VDI-Verlag • W. Bergmann: Werkstofftechnik I & II , Hanser Verlag • E. Macherauch, H.-W. Zoch: Praktikum in Werkstoffkunde, Vieweg Verlag • W. Weißbach: Werkstoffkunde und Werkstoffprüfung, Vieweg Verlag

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Mathematics 1** **Mathematik 1**
Module number	MAT-1-E
Module coordinator/ person responsible	Herr Prof. Dr. Ulf Teschke
Duration of the module/ semester/ frequency	1 Semester/ 1st semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	8 LP/ 8.00 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 136 h and Self-study: 104 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	Recommended: Content of preliminary course "Mathematics"
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The students • have a good command of elementary mathematics, elementary vector calculus including the basic operations of complex numbers in their different ways of representation • can solve simple linear systems of equations according to different methods • are able to derive and integrate elementary functions including their concatenations and integrate them, they know the necessary calculation rules • can atrribute simple physical and engineering problems to solving mathematical problems, this includes investigating functions, determinating limit values and solving extreme value problems • are able to represent mathematical functions in the corresponding series. The students are able to solve engineering problems with the methods of higher mathematics and to present them in a comprehensible way. They are aware of the role of higher mathematics in solving engineering and scientific problems. By the means of the offered tutorial, the students are motivated to work in a team.
Content of the module	In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Requirements for the award of credit points (Study and exam requirements)	Regular examination form for the module examination: Written examination (PL). Other possible forms of examination: oral examination. In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-style teaching (8 SHW), blackboard, beamer, practical examples, occasional presentations with numerical software (Matlab)

Literature	In the current edition: • Papula, L.: Mathematik für Ingenieure und Naturwissenschaftler, Bd 1,2, Vieweg Verlag • Papula, L.: Mathematische Formelsammlung für Ingenieure, Vieweg Verlag • Papula, L.: Klausur- und Aufgabensammlung, Vieweg Verlag • Stingl, P.: Mathematik für Fachhochschulen, Hanser Verlag • Westermann, T.: Mathematik für Ingenieure, Springer Verlag • Bronstein, I. N.; Semendjaew, K. A.; Musiol, G.: Taschenbuch der Mathematik, Harri Deutsch Verlag

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Mathematics 2** **Mathematik 2**
Module number	MAT-2-E
Module coordinator/ person responsible	Herr Prof. Dr. Ulf Teschke
Duration of the module/ semester/ frequency	1 Semester/ 2nd semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 5.00 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 85 h and Self-study: 65 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	Recommended: Mathematics 1
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The students can: • calculate partial derivatives, extreme values and integrals of functions of several independent variables. • calculate areas, volumes, centers of gravity, surface moments and mass moments of inertia of simple geometric bodies in Cartesian, polar and cylindrical coordinates • analyze and calculate vector analytical problems of multidimensional scalar and vector fields, they can determine line and surface integrals and know simple physical applications of these calculation methods • classify ordinary differential equations and solve simple DGLs, they master the solutions of the vibration equation and know the corresponding physical meanings • apply simple statistical methods and master simple regression methods. The students are also able to solve complex engineering problems with methods of higher mathematics and present them in a comprehensible way. They are aware of the role of higher mathematics in solving engineering and scientific questions. The offered tutorial motivates the students to work in teams.
Content of the module	• Functions of several independent variables: • Partial derivative, extreme values, total differential, determination of tangent plane, multiple integrals, calculation of areas, volumes, centers of gravity, moments of area and mass, variable transformations. • Vector analysis: differential geometry: parameter representation of curves, curvature, parameter representation of curves and surfaces, vector differential operators, line integral, surface integral, theorem of Gaus, theorem of Stokes • Ordinary differential equations: Separation of variables, 1st order differential equation, 2nd order linear differential equation, oscillation equation, systems of 1st order linear differential equations, classification of 2nd order partial differential equations, • Error and compensation calculation: mean value, standard deviation, variance, error of the mean value, error propagation, regression, correlation, normal distribution, frequency and probability

Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: oral examination. In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-style class (4 SHW), Exercise (1 SHW), blackboard, beamer, practical examples, occasional presentations with numerical software (e.g. Matlab)
Literature	In the current edition: • Papula, L.: Mathematik für Ingenieure und Naturwissenschaftler, Bd 2+3, Vieweg Verlag • Papula, L.: Mathematische Formelsammlung für Ingenieure, Vieweg Verlag • Papula, L.: Klausur- und Aufgabensammlung, Vieweg Verlag • Stingl, P.: Mathematik für Fachhochschulen, Hanser Verlag • Westermann, T.: Mathematik für Ingenieure, Springer Verlag • Bronstein, I. N.; Semendjaew, K. A.; Musiol, G.: Taschenbuch der Mathematik, Harri Deutsch Verlag

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Measurement and Control Systems** **Mess-, Steuer- und Regelungstechnik**
Module number	MSR-E
Module coordinator/ person responsible	Frau Prof. Dr. Birgit Koeppen
Duration of the module/ semester/ frequency	1 Semester/ 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	9 LP/ 8.00 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 136 h and Self-study: 134 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards. Recommended: Electrical Engineering Fundamentals
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	Students understand the main functions and problems of control engineering. They know the views and values of the field. They are able to apply this knowledge in their professional activities for the design and operation of control engineering devices and systems. They are able to independently select suitable methods for solving problems and to acquire new knowledge.
Content of the module	Open loop control: Logic circuits, Boolean algebra, logic controllers, circuit optimization, fundamentals of programmable logic controllers. Measurement technology: Electrical measurement of non-electrical quantities, examples of sensors, computer interfaces. Closed loop controlled systems: System modeling with differential equations, description and analysis of time response, frequency response, transfer function. Controller and control loops: Types of controllers, realization of controller behavior, reference and disturbance reaction of control loops, stability, control design. Laboratory practical course: Consolidation of selected chapters of the lecture.
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: Oral examination Laboratory practical course: Lab work completion (SL) In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-style class (6.5 SHW), blackboard and slides, presentation, laboratory practical (1.5 SHW), self-study
Literature	In current edition: • Franklin, Gene F.; Powell, J. David; Emami-Naeini, Abbas: Feedback Control of Dynamic systems, Upper Saddle River, NJ, Pearson Prentice Hall • Dorf, Richard C.; Bishop, Robert H.: Modern Control Systems, Upper Saddle River, NJ, Pearson Prentice Hall • Ogata, Katsuhiko: Modern Control Engineering, Boston, MA, Pearson

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Mechatronics** **Mechatronik**
Module number	MTR-E
Module coordinator/ person responsible	Herr Prof. Dr. Christian Rudolph
Duration of the module/ semester/ frequency	1 Semester/ 4th, 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards. Recommended: Electrical Engineering Fundamentals, Control Engineering, Electrical Drives
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The students are competent to analyze mechatronic systems and their components by applying methods of engineering mechanics, electrical engineering, control engineering, and systems theory for designing and evaluating mechatronic components in mechanical engineering practice.
Content of the module	• Modeling and simulation of mechatronic components • Control of electrical drives - actuators • System and parameter identification • Micro- and power electronics of selected mechatronic systems • Sensorless control methods • Sensors, measurement effects, sensor signals, sensor data processing, filters, development methodology (VDI 2206) • Laboratory practical course with computer laboratory for modeling, system analysis and design of electromechanical actuators as well as a test bench experiment of a servo drive
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: Oral examination Laboratory practical course: Lab work completion (SL) In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-style class (3 SHW) Laboratory practical course (1 SHW) Blackboard and slides, presentation, Class discussion in small groups in the pracitcal laboratory course

Literature	• All course materials including a collection of exercises • Laboratory script In the current edition: • Hering, E, Steinhart, H. (Hrsg.): Taschenbuch der Mechatronik, Fachbuchverlag Leipzig im Carl-Hanser-Verlag, München • Keviczky, L., Bars, R., Hetthessy, J., Banyasz, C.: Control Engineering, Springer Nature Singapore • Leonhard, W.: Control of Electrical Drives, Springer-Verlag, Berlin, Heidelberg, New York • Mohan, N., Undeland, T. M., Robbins, W. P.: Power Electronics, Wiley, Hoboken, NJ, USA

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Production Planning and Control** **Produktionsplanung und -steuerung**
Module number	PPS-E
Module coordinator/ person responsible	Herr Prof. Dr. Markus Stallkamp
Duration of the module/ semester/ frequency	1 Semester/ 4th, 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards. Recommended: Industrial Management
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	In this module, students become familiar with basic and special terms as well as methods of operational production planning and control for industrial enterprises. They should know and understand typical problems that occur in the phases from production program planning until production control and be able to solve them using mathematical procedures. Advantages and disadvantages of the procedures should be known. In the laboratory practical training, students should learn the basic and independent use of complex ERP software. Typical tasks, such as working with material masters, bills of material, routings, production orders and calculations, should be understood and completed using the SAP ERP system as an example.
Content of the module	Introduction to production and cost theory: • Production functions of type A and B Introduction to operational production planning and control: • Production program planning: one product or several with a bottleneck in production or several • Production demand planning: consumption-oriented and program-oriented Demand planning • Production demand planning: inventory management and machine allocation planning • Production control: Kanban, cumulative quantities, load oriented order release, Optimized Production Technology (OPT)
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: Oral examination, Portfolio examination Laboratory practical course: Lab work completion (SL). In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.

Learning and teaching types/ methods/ media types	Seminar-style class (3,5 LVS) Laboratory practical (1,5 LVS) Lecture, problem-based learning, single and group assignments, team work, ERP software SAP S4 HANA, enterprise simulation game
Literature	In current edition: Kiran, D. R.: Production planning and control - a comprehensive approach Lödding, H.: Handbook of Manufacturing Control - Fundamentals, description, configuration Nyhuis, P.; Wiendahl, H.-P.: Fundamentals of Production Logistics Wada, K.: The evolution of the Toyota production system. Singapore, Springer

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Project Management Fundamentals / Bachelor Project Bachelorprojekt**
Module number	BACPJ-E
Module coordinator/ person responsible	Herr Prof. Dr. Henner Gärtner
Duration of the module/ semester/ frequency	1 Semester/ 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	6 LP/ 3.50 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 60 h and Self-study: 120 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	-
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	Technical, content-related and methodological competences: Within the bachelor's degree program, the bachelor project is the central training unit for acquiRING methodological and social competence in teamwork on a typical study project. Students receive the competence to work according to classical and agile forms of project management. Social and personal competences: In addition to the methods for dealing with complexity and uncertainty in projects, social competence in connection with the risky project topics chosen is a central training objective of this module.
Content of the module	The training focuses in particular on the start of the project in order to avoid the typical mistakes with serious consequences that often occur in practice. This includes methods for both scheduling and organizational project preparation. The lectures are to be directly applied in the parallel bachelor project. For this purpose, 3 teaching units are formed: 1) The first unit (3 times 2 quarters) teaches the basics of the including a risk assessment and a detailed preparation for the status report. 2) In the middle of the semester, there is a status report (1 quarter) per Project Team, the results of which are discussed as examples. Through these positive aspects of other groups can be taken up and errors can be corrected. 3) The final part (1 quarter) is a feedback concerning the supervisor, the team and the lecture in the group and as a personal evaluation.
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the seminar-style class: Portfolio examination (SL). Regular form of examination for the project: Project (SL).
Learning and teaching types/ methods/ media types	Seminar-style class (1 SWS), Project (2,5 SWS) in teams of ca. 4 students: Group work, report preparation, poster preparation, powerpoint presentation by means of beamer, slides, blackboard, software

Literature	Lecture notes of teaching professors Dr.-Ing. Birgit Koeppen, Dr.-Ing. Henner Gärtner, Dr. Markus Stallkamp, Dr.-Ing. Tobias Held, Dr. Mauricio de Campos Porath, Dr.-Ing. Thomas Richters You find several literature references in the continuously updated script. As basic literature with a very good mixture of methodological procedures and also communication aspects we recommend (in the current edition): • Kuster, J. et al. (Eds): Project Management Handbook: Agile - Classic - Hybrid. Berlin, Heidelberg: Springer Berlin Heidelberg. • Gubbels, H. (Ed). SAP® Professionelles Projektmanagement – aktualisiert auf ECC 6.0. Wiesbaden: Vieweg+Teubner. [Online]. Available at: doi:10.1007/978-3-8348-9967-5_1 • A highly recommended, 1998 issued but still very actual novel on project management is: de Marco, Tom: The Deadline – A Novel about Project Management. https://doi.org/10.1145/272263.565645

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Robot-based Manufacturing** **Roboterbasierte Fertigung**
Module number	RBF-E
Module coordinator/ person responsible	Herr Prof. Dr. Shahram Sheikhi
Duration of the module/ semester/ frequency	1 Semester/ 4th, 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards.
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	Students are able to independently explain various different manufacturing processes in interaction with jointed-arm robots as handling systems and discuss their advantages and disadvantages in the field of manufacturing. They will know possibilities and strategies to use robots economically. They will be able to consider and justify the special features of robot-based manufacturing in the production of a component. Students will be able to apply quality assurance methods to ensure reproducible quality. In doing so, they will know the most important parameters that exert an influence on quality. The students should learn to be able to apply the robot language independently to problems in production. In doing so, the students will be able to apply, explain and justify both language-based programming and programming via virtual tools. Thus they have the following competencies: • Consideration of comprehensive process chains for robot-based manufacturing • Interaction between robots and manufacturing processes • programming • Safety requirements
Content of the module	• Fundamentals of manufacturing processes (welding, forming and machining) • Fundamentals of robot programming, interaction between manufacturing processes and robots; application of virtual environments for programming and testing, sensor technology and its integration.
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Oral examination (PL). Other possible forms of examination: Written examination, Portfolio examination Laboratory practical course: Lab work completion (SL) In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-style class (3 SHW), Laboratory practical course (1 SHW)

Literature	In current edition: • Hesse, Stefan; Malisa, Viktorio: Taschenbuch Robotik - Montage – Handhabung; ISBN: 978-3-446-44365-5 • Fahrenwaldt, Hans, J: Praxiswissen Schweißtechnik - Werkstoffe Prozesse Fertigung, Springer Vieweg • Doege, E.; Behrens, B.-A.: Handbuch Umformtechnik – Grundlagen, Technologien, Maschinen. Berlin, Springer-Verlag

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Software Applications in Mechanical Engineering** **Softwareanwendungen im Maschinenbau**
Module number	SOM-E
Module coordinator/ person responsible	Herr Prof. Dr. Ivo Nowak
Duration of the module/ semester/ frequency	1 Semester/ 4th, 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards.
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The students • are prepared for the complex challenges of information technology in mechanical engineering. • can implement software solutions for current topics in product development in mechanical engineering in an object-oriented programming language and explain the underlying principles. • possess knowledge of modern software development and model-based simulation and control.
Content of the module	1. Basics industry 4.0 and cyberphysical systems 2. Basics of object-oriented programming 3. Control of hardware components 4. Internet-of-things data exchange 5. Model-based simulation and control 6. Practical project
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Project (PL). Other possible forms of examination: Oral examination, Written exam Laboratory practical course: Lab work completion (SL) If there is more than one possible form of examination in the module, the responsible lecturer will announce the form of examination to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-style class (3 SHW), Laboratory practical course (1 SHW), Project work, eLearning, self-study. In order to apply the learned skills, exercises on the computer take place in parallel to the lecture and software solutions are developed in practical projects
Literature	In current edition: • Weigend, Michael: Python 3 - Lernen und professionell anwenden. • Weigend, Michael: Raspberry Pi programmieren mit Python. • Ernesti, Johannes ; Kaiser, Peter: Python 3: Das umfassende Handbuch: Sprachgrundlagen, Objektorientierung, Modularisierung • Fritzson, Peter: Principles of Object-Oriented Modeling and Simulation with Modelica 3.3: A Cyber-Physical Approach

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Study Research Paper** **Studienarbeit**
Module number	SAB-E
Module coordinator/ person responsible	Herr Prof. Dr. Enno Stöver
Duration of the module/ semester/ frequency	1 Semester/ 1 Semester/ 4th, 5th or 6th semester/ Annually (German language programme usually every semester)/ Every Semester
Credits (CP)/ semester hours per week (SHW)	5 LP/ 0.00 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 0 h and Self-study: 150 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards.
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	In this study research paper, students deepen and broaden their knowledge acquired so far by means of a concrete task. They model systems, procedures and processes with the help of modern computing technology and computational methods or carry out experiments on laboratory systems, evaluate them and present the results in a coherent manner. The students learn to present complex interrelationships in a comprehensive written form, and they learn to distinguish the essential from the unessential. The students learn to describe their results in a scientific presentation of their results in written form. Students are able to able to • to deepen and familiarize themselves with a technitext form, using primary and secondary literature. The students are able • to work out the state of the art for solving the task at hand and to take this into account when solving the problem, • to include and evaluate business aspects in the solutions evaluate them, • to take the system concept into account in the solution and to develop interdisciplinary to work out interdisciplinary solutions.
Content of the module	In-depth content from the modules of the 1st-4th semesters on various topics
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written Paper (PL)
Learning and teaching types/ methods/ media types	Independent self-study
Literature	Requirements for the written version of student papers, Guideline of the Department of Mechanical Engineering and Production According to the modules of the assignment, journals, standards, leaflets

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Systematic Product Development** **Methodische Produktentwicklung**
Module number	MPE-E
Module coordinator/ person responsible	Herr Prof. Dr. Andreas Meyer-Eschenbach
Duration of the module/ semester/ frequency	1 Semester/ 4th, 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards.
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The students know and understand different models for describing product development processes. They can generate new product ideas taking into account existing restrictions and constraints and develop a strategic positioning for them step by step. They will be able to analyze different scenarios for the use and operation of products and derive and formulate user-oriented requirements from them. They are able to abstract technical problems in order to identify the essence of the problem and thus the actual customer need. Students will be able to model and describe the function of technical systems in a process-oriented manner. They can systematically develop and evaluate their own solution concepts for given technical problems. They know important design guidelines and principles and can implement these within the framework of their own design drafts. Students understand the fundamentals of preventive quality and risk management in product development.
Content of the module	• Process models of product development processes • Strategic product planning • Requirements management • Abstraction of technical problems • Functional modeling of technical systems • Methods for finding solutions • Methodical concept development • Selection and evaluation methods • Basics of preventive quality and risk management • Design guidelines and principles
Requirements for the award of credit points (Study and exam requirements)	Standard form of examination for the module examination: Portfolio examination (PL) Other possible forms of examination: Written paper, Written exam. Laboratory practical course: Lab work completion (SL). In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.

Learning and teaching types/ methods/ media types	• Seminar-style class (3 SHW) • Laboratory practical course (1.5 SHW) • Exercises and case studies in individual and group work • Project work in groups • Student presentations with differentiated feedback • Written elaborations • Practical examples • Self-study
Literature	• Lecture notes • Further literature will be announced by the lecturer

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Technical Drawing and CAD** **Maschinenzeichnen und CAD**
Module number	MZCAD-E
Module coordinator/ person responsible	Herr Prof. Dr. Udo Pulm
Duration of the module/ semester/ frequency	1 Semester/ 1st semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	6 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 68 h and Self-study: 112 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	Recommended: Content of preliminary course in Technical Drawing
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	At the end of the semester, students will be familiar with the standard-compliant methods of representing technical components and products and will be able to apply these in a design context. Furthermore, they acquire the ability to make freehand sketches. At the end of the labs, students will be able to produce consistent CAD models and derived standard-compliant drawings of technical products independently and in small groups with all manufacturing and assembly details as well as parts lists.

Content of the module	For the Technical Drawing part: • Types of technical drawings, types of standards Drawing formats, sheet folding, scales, characters, line types • Dimensioning (types of dimensions, rules of dimensioning, simplification in dimensioning) • Representation of general workpieces (projection methods, views, sectional views, hatching) • Representation of shafts, of assemblies with bolted joints and of welded joints • Surface finish specifications (edge finish, roughness specifications, hardness specifications) • Tolerances and fits (basics, general tolerances, clearance, transition and interference fits, unit bore, unit shaft, form and position tolerances) • Tolerance chains and tolerance chain analysis • Interaction of technical drawing and parts list • Creation of freehand sketches For the CAD part: • Essential characteristics and performance of CAD systems • Basics of geometry modeling (CSG and B-Rep modeling) • Parametrics and associativity • CAD interfaces, use of CAD data in the product development process, CAx methods • Modeling with different KE (construction elements) • Top-down and bottom-up design • CAD data management systems (PLM) • Kinematics / motion simulation Laboratory: • Component recording/sketching of components or assemblies • Bolted joints and simple assemblies as standardized technical drawings • CAD modeling of components with the help of different KE • (construction elements) • CAD-assembly of components to assemblies • Production-ready representation of a component with CAD • Creation of parts lists and exploded drawings: • Parameterized components/assemblies • Drawing derivation • Optional: Kinematics and further features
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Portfolio examination (PL). Other possible forms of examination: Written examination, Written paper, Oral examination. Laboratory practical: Lab work completion (SL). In case of more than one possible form of examination in the module, the responsible teacher will announce the form of examination to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-style class (2.5 SHW) Laboratory practical course (1.5 SHW): Centional drawing exercises, sketching as well as modeling with CAD system

Literature	In current edition: • Hoischen, H.; Hesser, W.: Technisches Zeichnen. Cornelsen Verlag, Berlin • Labisch S.; Weber, C.: Technisches Zeichnen. Springer-Vieweg Verlag, München • Viebahn, U.: Technisches Freihandzeichnen. Springer, Berlin. Tabellenbuch Metall. Verlag Europa Lehrmittel. Haan-Gruiten • Klein, M.: Einführung in die DIN Normen. DIN Deutsches Institut für Normung e.V. Teubner Verlag, Stuttgart • Meyer, A.: CREO-Parametric 3.0 für Forschgeschrittene - kurz und bündig. Springer-Verlag • Wyndorps, P.: 3D-Konstruktion mit CREO- Parametric, Europa Lehrmittel Verlag

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Technical Thermodynamics 1** **Technische Thermodynamik 1**
Module number	TTD1-E
Module coordinator/ person responsible	Herr Prof. Dr. Achim Schmidt
Duration of the module/ semester/ frequency	1 Semester/ 3rd semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory module of the core curriculum
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	Recommended: Mathematics 1, Mathematics 2
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	Students should be able to carry out thermodynamic balances of machines and systems in the project phases of planning, calculation, construction and operation. They should understand the importance of energy conversion and the quality of the various forms of energy. In addition, they will have a profound knowledge of the thermodynamic properties of various working fluids. The aim of the module is to provide both technical and methodological expertise. Practical examples are used to develop methods for thermodynamic calculations. In order to transfer the thermodynamic knowledge to technical applications, the view for the essentials is sharpened.
Content of the module	• General basics/introduction • Task of thermodynamics • System and state, system boundary, state values, fluid phases • Temperature, thermal/mechanical balances, zeroth law of thermodynamics, ideal gas thermometer, thermal equation of state for ideal gases • Internal energy as state value, caloric equation of state • Heat and work, volume change work, shaft work, heat and heat flux, heat transfer • First law of thermodynamics – energy balances • Closed systems • Open systems (unsteady processes, steady state systems) • Enthalpy as state value • Second law of thermodynamics • Entropy, entropy balances for open and closed systems • Irreversibility of heat transfer phenomena, transient balancing • Thermal engines • Entropy as state value, T,s-diagram • Limited conversion ability of energy – idea of exergy • Thermodynamic cycles • Heat pumps, cooling machines • Carnot-cycle • Clausius-Rankine process

Requirements for the award of credit points (Study and exam requirements)	Regular examination type for module testing: Written examination (PL) Further possible examination types: Oral examination. Where more than one possible examination type is used in the module, the examination type to be used is to be made known by the responsible lecturer at the start of the course.
Learning and teaching types/ methods/ media types	Seminar-style class (4 SHW) Tuition in seminars, blackboard, slides
Literature	In current edition: • Schmidt, A.: Technical Thermodynamics for Engineers, Springer • Baehr, H. D.; Kabelac, S.: Thermodynamik. Grundlagen und technische Anwendungen. 13. Auflage. Berlin, Heidelberg: Springer • Cerbe, G.; Wilhelms, G.: Einführung in die Thermodynamik. Von den Grundlagen zur technischen Anwendung. 14. Auflage. München, Wien: Carl Hanser

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Technical Thermodynamics 2** **Technische Thermodynamik 2**
Module number	TTD2-E
Module coordinator/ person responsible	Herr Prof. Dr. Achim Schmidt
Duration of the module/ semester/ frequency	1 Semester/ 4th, 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards. Recommended: Mathematics 1, Mathematics 2, Technical Thermodynamics 1, Fluid Mechanics 1
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The students will be able to apply thermodynamic correlations in the planning, calculation, construction and operation of machines, apparatus and plants based on the knowledge they have acquired. They will be able to understand the significance, convertibility and valency of the various forms of energy and have knowledge of thermodynamic properties of pure substances, ideal gas mixtures and gas-vapour mixtures. They will be able to calculate steady and unsteady thermodynamic processes. The course imparts both technical competence and methodological competence. Methods of calculation are worked out based on practical examples. The sense for the essentials is sharpened and mathematical competence is trained for the transfer to technical applications.

Content of the module	Thermodynamic properties of pure fluids: • Thermal state variables, p,v,T-area, wet steam region, wet vapour, vapour pressure, boiling temperature, state values in the wet steam region • State diagrams, calculation of enthalpy and entropy, steam tables Stationary flow processes: • Technical work, dissipation of energy and changes of state in open systems (e.g. turbines, compressors, nozzle, diffusor) Thermodynamic Cycles: • Heat pumps and cooling machines, thermal engines, Clausius-Rankine process, refrigerants, log p,h-diagrams Ideal gas mixtures: • Thermal/caloric equations of state, mixing properties, ideal gas-vapour mixtures, irreversibility of mixing • Saturation partial pressure and dew point, humidity, water load, specific volume, enthalpy and entropy of humid air, h,x- diagram, simple processes with gas-steam mixtures and humid air, HVAC Combustion processes: • Stoichiometry of combustion, energetics of combustion processes, energy balance, heating value, h,theta-diagram, flue gas losses, boiler efficiency, adiabatic combustion temperature, exergy of fuels, exergy loss during combustion, enthalpy of formation/entropy method • Basics on modern Fuel Cell applications
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: Oral Examination. Laboratory practical course: Lab work completion (SL). In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-based teaching (3 SHW), Laboratory practical course (1 SHW) • E-learning • Self-study • Exercises and/or lab assignments, case studies if applicable, approaches of the flipped classroom concept if applicable • Presentations (blackboard, slides, PPT / beamer, teaching videos, etc.), software use on PC, media of e-learning, scripts and/or handouts • Laboratory practical course, work on the computer, self-study, lab exercises
Literature	In current edition: • Schmidt, A.: Technical Thermodynamics for Engineers, Springer-Verlag • Lucas, K.: Thermodynamik - Die Grundgesetze der Energie- und Stoffumwandlungen, Springer Verlag • Baehr, H.D., Kabelac, S.: Thermodynamik, Springer Verlag • Cerbe, G.; Wilhelms, G.: Einführung in die Thermodynamik. Von den Grundlagen zur technischen Anwendung. München, Wien: Carl Hanser Verlag • Herwig, H., Kautz, C.H.: Technische Thermodynamik, Pearson Studium • Hahne, E.: Technische Thermodynamik: Einführung und Anwendung, De Gruyter Oldenbourg

Course of study/ focus of study: B.Sc. Maschinenbau und Produktion B.Sc. Maschinenbau und Produktion (dual) B.Sc. Maschinenbau / Energie- und Anlagensysteme B.Sc. Maschinenbau / Entwicklung und Konstruktion B.Sc. Produktionstechnik und -management B.Sc. Mechanical Engineering	
Module name / title (german)	**Technische Thermodynamik 1(engl.)** **Technical Thermodynamics 1**
Module number	TTD-1e
Module coordinator/ person responsible	Frau Prof. Dr. Heike Frischgesell
Duration of the module/ semester/ frequency	1 Semester/ third semester/ each semester
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Pflichtfach im Kernstudium
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The students shall be qualified to perform thermodynamic balances of machines and facilities within the project stages planning, calculation, design and operation. They shall understand the meaning of energy conversion and the quality of different forms of energy. Furthermore, they shall have a consolidated knowledge of thermodynamic properties of different working fluids. The module's task is to mediate expertise as well as methodical competence. Methods for thermodynamical calculations will be developed by using practical examples. In order to transfer the thermodynamical knowledge into engineering applications the view for the essentials is sharpened.

Content of the module	• General basics/introduction • Task of thermodynamic • System and state, system border, variables of state, fluid phases, equation of state • Temperature, thermal balance, ideal gas thermometer, thermal equation of state (ideal and real gases), standard volume • First law of thermodynamic • Closed systems • Internal energy, caloric equation of state • Energy balances • Heat and work, volume change work, shaft work, heat and heat flux, heat transfer • Open systems (unsteady processes, steady state systems) • Enthalpy • Second law of thermodynamic • Entropy, entropy balances for open and closed systems • Irreversibility of heat transfer phenomena, cooling processes • Thermal engine • Entropy as state variable, T,s-diagram • Limited conversion ability of energy • Thermodynamic cycles • Heat pumps, cooling machines • Carnot-cycle • Clausius-Rankine process
Requirements for the award of credit points (Study and exam requirements)	Regular examination type for module testing: Written exam (PL) Further possible examination types: oral exam Where more than one possible examination type is used in the module, the examination type to be used is to be made known by the responsible lecturer at the start of the course.
Learning and teaching types/ methods/ media types	Tuition in seminars, blackboard, slides
Literature	Baehr, H. D.; Kabelac, S.: Thermodynamik. Grundlagen und technische Anwendungen. 13. Auflage. Berlin, Heidelberg: Springer-Verlag 2006. Cerbe, G.; Wilhelms, G.: Einführung in die Thermodynamik. Von den Grundlagen zur technischen Anwendung. 14. Auflage. München, Wien: Carl Hanser Verlag 2005. Doering,E.; Schedwill, H.; Dehli, M.: Grundlagen der Technischen Thermodynamik. 5. Auflage. Stuttgart, Leipzig, Wiesbaden: B. G. Teubner Verlag 2005.

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Technology and Ethics** **Technik und Ethik**
Module number	TET-E
Module coordinator/ person responsible	Herr Prof. Dr. Udo Pulm
Duration of the module/ semester/ frequency	1 Semester/ 4th, 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	Whether nuclear power or autonomous driving, artificial intelligence or climate change, robotics or biotechnologies, agriculture or mobility or medical technology - engineers have to deal increasingly with the ethical consequences of their actions. If you are interested and willing to look beyond the purely technical, this module gives you the opportunity to evaluate the significance of technical developments for society and the environment. If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards.
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The students • know the basics of ethics, • know basic issues and methods from the field of technology and ethics, • develop an awareness of ethics-relevant issues and learn to recognise ethics-relevant problem situations, • are able to analyse (by means of case studies) real socio-technical problem situations in depth using different ethics concepts, • can evaluate and assess individual, social, and institutional actions in socio-technical situations, • practice strategies for appropriate problem solving, • are able to bring about and make ethics-related decisions.

Content of the module	• Fundamentals of ethics (definitions, concepts, terms, methods, guiding principles, values) • Ethics in technical civilisation and the information age • Codes of ethics (in technical professions) • Individual ethics, institutional ethics, social ethics etc. • Technology assessment • Life cycle assessment, carbon footprint • Moral conflicts and how to deal with them • Responsibility • Environmental protection and sustainability • Strategic Development Goals (SDGs) • History of technology and technical progress • Management systems such as environmental management, anchoring in management and organisation • Importance of interdisciplinarity • Machine ethics • Case studies (such as nuclear power, automation, artificial intelligence, autonomous driving, environmental protection, data protection, etc.) • Discussion of current problems
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module: Portfolio examination. Other possible forms of examination: Homework, written examination. If there is more than one possible form of examination in the module, the responsible lecturer will announce the form of examination to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-based teaching (3 SHW), Laboratory practical course (1 SHW) Presentations, lecture series, practical exercises/case studies, inverted classroom etc.
Literature	• Lenk, Hans; Ropohl, Günter: Technik und Ethik. Stuttgart: Reclam 1993. • Grunwald, Armin: Handbuch Technikethik. Stuttgart: Springer 2013. • Grundwald, Armin: Technology Assessment. Taylor & Francis 2018. • Ropohl, Günter: Ethik und Technikbewertung. Frankfurt: Suhrkamp 1996. • Fenner, Dagmar: Einführung in die angewandte Ethik. Stuttgart: UTB 2010. • Detzer, Kurt: Wer verantwortet den industriellen Fortschritt? Auf der Suche nach Orientierung im Geflecht von Unternehmen, Gesellschaft und Umwelt. Stuttgart: Springer 2012. (Skript) • Rath, Matthias: Maschinenethik: Normative Grenzen autonomer Systeme. Stuttgart: Springer 2018. • Marx, Thomas: Technikfolgenabschätzung und Risikobewertung: Technikfolgenabschätzung und Risikobewertung unter dem Gesichtspunkt der Technikphilosophie und des ethischen Handelns. München: GRIN 2010. • Grunwald, Armin: Technikfolgenabschätzung - eine Einführung. Berlin: edition sigma 2010. • Bendel, Oliver: Handbuch Maschinenethik. Stuttgart: Springer 2019. Further literature and other media will be announced by the teacher at the beginning of the course.

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Thermal Modeling of Real Systems** **Thermische Systemmodellierung**
Module number	TSM-E
Module coordinator/ person responsible	Herr Prof. Dr. Martin Lauer
Duration of the module/ semester/ frequency	1 Semester/ 4th, 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards. Recommended: Fundamentals of Mathematics 1, Mathematics 2, Technical Thermodynamics 1, Fluid Mechanics 1
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	Upon successful completion of this class, students can analyze and model thermal and energetic flows, energy transfer processes and transient thermal behavior of idealized and non-idealized technical applications and thermal power machinery. This includes: • The analysis and modeling of energetic systems • The application of common conservation equations to application-oriented problems • The analysis, evaluation, and application of different approaches to specific problems, particularly to technical challenges related to energy production and energy transfer Furthermore, the students gain the following skills: • Mastering the principles of common numerical methods and solving complex energetic processes numerically • Handling and application of material data databases for ideal and real substances • Programming in a digital workflow The skills and the knowledge taught in this class allow the students to understand and design sustainable products and applications in the field of power engineering in an international environment.

Content of the module	Basics of numerical methods aimed at heat transfer and thermal engineering problems: • Steady state and transient heat equation with and without heat sources, e.g., Binder-Schmidt method • Basics of finite difference method for the solution of partial differential equations • Numerical solution of heat equation problems Modeling of real technical applications with, e.g., Dymola/Simulink: • Transient thermodynamic systems, e.g., loading and unloading of thermal storages • Building and room air conditioning • Thermodynamic cycles • Dynamic energetic transformation processes Calculation of reacting and non-reacting flows: • Method of absolute enthalpy/entropy • Calculation of combustion temperature (e.g., with Cantera via Matlab or Python) Specific energetic problems: • Equation of state for real fluids • Modeling of ideal gas mixtures • Application of material data databases for ideal and real substances
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: Oral Examination. Laboratory practical course: Lab work completion (SL) In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-based teaching, laboratory practical, e-learning, self-study Exercises and/or laboratory tasks, case studies if applicable, approaches of the flipped classroom concept if applicable. Presentations (blackboard, slides, PPT / beamer, teaching videos, etc.), software use on the PC, media of e-learning, lecture notes and/or handouts Laboratory practical, work on the computer (e.g. with Ansys, Matlab/Simulink, Dymola, Excel, Open Source e.g. Cantera/Python), self-study
Literature	In current edition: • Baehr, H.D., Kabelac, S.: Thermodynamik, Springer • Schmidt, A.: Technical Thermodynamics for Engineers, Springer • v. Böckh, P., Stripf, M.: Thermische Energiesysteme, Springer • Baehr, H.D., Stephan, K.: Wärme- und Stoffübertragung, Springer • Patankar, S.: Numerical Heat Transfer and Fluid Flow. Taylor & Francis

Course of study/ focus of study: B.Sc. Mechanical Engineering	
Module name / title (german)	**Wind Turbines** **Windenergieanlagen**
Module number	WEA-E
Module coordinator/ person responsible	Herr Prof. Peter Dalhoff
Duration of the module/ semester/ frequency	1 Semester/ 4th, 5th or 6th semester/ Annually (German language programme usually every semester)
Credits (CP)/ semester hours per week (SHW)	5 LP/ 4.00 SWS
Type of module , Applicability of the module	Mandatory elective module of the in-depth studies
Workload	Contact hours: 68 h and Self-study: 82 h (Basis: 17 semester weeks (incl. exam time), 1 SHW = 60 minutes)
Module prerequisites Requirements for participation/ previous knowledge	Recommended: Engineering Mechanics 1-3, Machine Elements and Systems, Fluid Mechanics If 1st semester graded (PL) or non-graded (SL) parts of a module exam are missing, no examination work can be taken from the 4th semester onwards.
Teaching language	Teaching language: English Alternate teaching language: German If there is more than one teaching language, the used teaching language will be announced by the lecturer.
Competencies gained/ Learning Outcome	The students acquire the ability to independently model, computationally design and construct wind turbines in a simplified manner with regard to their energy yield, loads, and service life. The students learn to apply the basics of aerodynamics to the wind turbine in order to establish fundamental relationships between wind, power, energy yield and load using analytical methods. On this basis, students are able to understand turbine concepts and their structural design.
Content of the module	• Basic design principles and concepts of wind turbines • Design and components/systems of wind turbines for power generation • Aerodynamic principles and maximum power coefficient according to Betz • Aerodynamic losses and aerodynamic power coefficient • Mechanical, electrical losses, and power curve • Site conditions and energy yield • Structural loading and structural dynamics of wind turbines • Design and strength of selected turbine components
Requirements for the award of credit points (Study and exam requirements)	Regular form of examination for the module examination: Written examination (PL). Other possible forms of examination: Oral Examination Laboratory practical course: Lab work completion (SL) In case of more than one possible examination form in the module, the responsible lecturer will announce the examination form to be taken at the beginning of the course.
Learning and teaching types/ methods/ media types	Seminar-style class (3 SHW), Laboratory practical course (1 SHW), Self-study, if necessary guest lectures, project-related work / blackboard, slides, PC, beamer
Literature	In current edition: • Gasch, R; Twele, J.: Windkraftanlagen. Teubner • Hau, E.: Windkraftanlagen. Springer • Burton, T. et. al.: Wind Energy Handbook. Wiley