Brandenburgische Technische Universität Cottbus - Senftenberg
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Brandenburgische
Technische Universität
Cottbus - Senftenberg

Modulhandbuch für den Studiengang Power Engineering (universitäres Profil), Master of Science, Prüfungsordnung 2016

Inhaltsverzeichnis

Module 11491 Master Thesis

assign to: Total Account

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11491	Mandatory

Modul Title	**Master Thesis** Master-Arbeit
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Schiffer, Johannes
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every semester
Credits	30
Learning Outcome	The students prove that they are able to process specific tasks under the guidance of a supervisor independently and successfully and can implement scientifically grounded theoretical and practical knowledge for the solution of problems.
Contents	The content of the thesis can be theoretically as well as practically oriented. It should correspond to the latest scientific knowledge in the educational filed and should deal with the problems which occur in praxis. A Master thesis consists of a written work (which might include hardware and software components) and its defence.
Recommended Prerequisites	none
Mandatory Prerequisites	By the time of the registration of a master thesis a student should achieve at least 70 credit points.
Forms of Teaching and Proportion	Research paper/essay - 900 hours
Teaching Materials and Literature	Required material will be provided by a thesis supervisor.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Written paper (75%) • Presentation and colloquium (25%)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none

Remarks	none
Module Components	none
Components to be offered in the Current Semester	No assignment

Module 11196 Introduction in Electrical Power

assign to: Common Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11196	Compulsory elective

Modul Title	**Introduction in Electrical Power** Einführung in elektrische Energiesysteme
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Malekian Boroujeni, Kaveh
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The students are able to distinguish and reflect on the relationships between the different fields of the electrical power supply. In addition to the different types of generation, the student can also analyse the various grid types with their different operating elements. Furthermore, the student can also recognise influences on the power quality and evaluate them accordingly.
Contents	• Basics in single phase and three phase systems • Conventional power plants • Generators • Transformers • Operation under normal and fault conditions • Overvoltages
Recommended Prerequisites	Basic understanding in electrical engineering
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Script
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Written examination, 90 minutes

Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	• The lecture will give a short introduction to students with bachelor degrees in electrical engineering (or others), who had no subjects in electrical power engineering in their undergraduate programmes • another registration for this module in moodle • different forms of teaching are announced in moodle
Module Components	• Introduction in Electrical Power (lecture/exercise)
Components to be offered in the Current Semester	**320169** Lecture/Exercise Introduction in Electrical Power - 4 Hours per Term **320173** Examination Introduction in Electrical Power

Module 11494 Control Engineering 1

assign to: Common Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11494	Compulsory elective

Modul Title	**Control Engineering 1** Regelungstechnik 1
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Schiffer, Johannes
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	On completion of this module, students should be able to: • Analyze the behavior of linear dynamical systems in the frequency domain; • Design single-input-single-output controllers in the frequency domain; • Control linear systems with time delays; • Have developed an understanding for the application of control engineering methods to real-world applications based on examples and laboratory exercises.
Contents	Feedforward and feedback control; Fundamentals on signals and systems (repetition); Description of dynamical systems in the time and frequency domains; Frequency response; Control system properties and specifications; Stability; Hurwitz criterion; Nyquist criterion; Bode diagrams; Controller synthesis in the frequency domain; PID control; Cascaded control; Control of systems with time delays.
Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Laboratory training - 1 hours per week per semester Self organised studies - 105 hours
Teaching Materials and Literature	• K. J. Åström and R. M. Murray, "Feedback Systems", Princeton University Press, 2009

- G. F. Franklin, J. D. Powell, A. Emami-Naeini, "Feedback Control of Dynamic Systems", Vol. 3. Reading, MA: Addison-Wesley, 1994
- J. Lunze, "Regelungstechnik 1", Springer-Verlag, 2013
- Unbehauen, Heinz, "Regelungstechnik I – Klassische Verfahren zur Analyse und Synthese linearer kontinuierlicher Systeme", Vieweg Verlag Braunschweig/Wiesbaden

Module Examination

Prerequisite + Final Module Examination (MAP)

Assessment Mode for Module Examination

Prerequisite:
- Submission of at least 65% of the online homework
- Successful participation in all lab sessions including short tests (ungraded)

Final Module Examination:
- Written exam, 90 minutes

Permitted aids are **two** DIN A4 sheets, **handwritten** on both sides. For calculations, non-programmable calculators are allowed. Any other type of electronic device is **not** allowed. For successfully completed online homework, a maximum of 10% bonus points can be earned for the final examination.

Evaluation of Module Examination

Performance Verification – graded

Limited Number of Participants

none

Remarks

none

Module Components

- Control Engineering 1 (lecture)
- Control Engineering 1 (exercise/practical training)
- Control Engineering 1 (exam)

Components to be offered in the Current Semester

320630 Lecture
Control Engineering 1 - 2 Hours per Term
320631 Exercise/Practical training
Control Engineering 1 - 3 Hours per Term
320673 Examination
Control Engineering 1

Module 11747 Control Engineering 2

assign to: Common Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11747	Compulsory elective

Modul Title	**Control Engineering 2** Regelungstechnik 2
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Schiffer, Johannes
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	On completion of this module, students should be able to: • Model dynamical multiple-input-multiple-output (MIMO) systems from diverse domains in state-space form; • Analyze the behavior of linear state-space systems; • Understand the concepts of controllability and observability for linear time-invariant (LTI) systems; • Design static and observer-based dynamic state-feedback controllers for LTI MIMO systems.
Contents	State space modeling of dynamical systems; Dynamic behavior of linear systems; Solution of linear time-invariant systems; Lyapunov stability; Controllability and observability; State feedback; Pole placement; PI state feedback control; Control design via linear matrix inequalities; Duality principle; Luenberger-observer and observer-based control; Separation principle; Optimal control (Linear quadratic regulator, H-infinity control)
Recommended Prerequisites	Knowledge in: • Mathematics • Physics • Control Engineering 1 (or equivalent)
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Laboratory training - 1 hours per week per semester Self organised studies - 105 hours

Teaching Materials and Literature	• K. J. Åström and R. M. Murray, "Feedback Systems", Princeton University Press, 2009 • G. F. Franklin, J. D. Powell, A. Emami-Naeini, "Feedback Control of Dynamic Systems", Vol. 3. Reading, MA: Addison-Wesley, 1994 • H. Khalil, "Nonlinear Systems", Prentice-Hall, New Jersey, 1996 • J. Lunze, "Regelungstechnik 2: Mehrgrößensysteme Digitale Regelung", Springer-Verlag, 2013
Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	Prerequisite: • Submission of at least 65% of the online homework • Successful participation in all lab sessions including short tests (ungraded) Final Module Examination: • Written exam, 90 minutes Permitted aids are **two** DIN A4 sheets, **handwritten** on both sides. For calculations, non-programmable calculators are allowed. Any other type of electronic device is **not** allowed. For successfully completed online homework, a maximum of 10% bonus points can be earned for the final examination.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Control Engineering 2 (lecture) • Control Engineering 2 (exercise/laboratory) • Control Engineering 2 (exam)
Components to be offered in the Current Semester	**320671** Examination Control Engineering 2

Module 14414 Data Analytics and Process Modelling

assign to: Common Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	14414	Compulsory elective

Modul Title	**Data Analytics and Process Modelling** Datenanalyse und Prozessmodellierung
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. rer. nat. Röntzsch, Lars
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The students learn to develop, evaluate and validate models, design experiments and analyse data. The focus is placed on practical applications, particularly in process and energy technology. Students are also familiarised with soft sensors and digital twins.
Contents	1. Process Modelling and System Identification 2. Statistics and Data Visualisation 3. Theoretical Foundation for Statistical Analysis 4. Regression Analysis 5. Design of Experiments 6. Soft Sensors and Digital Twins
Recommended Prerequisites	Knowledge of advanced mathematics as well as physics or a basic engineering subject (e.g. electrical engineering, mechanics or thermodynamics) at the university bachelor's level
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	The course materials will be provided through Moodle. Literature: • Shardt, Yuri: Statistics for Chemical and Process Engineers. A Modern Approach. 2nd edition (2022). DOI: 10.1007/978-3-030-83190-5.

	• Shardt, Yuri (2023): Using MATLAB to Solve Statistical Problems. DOI: 10.1007/978-3-031-40299-9. • Shardt, Yuri (2024): Using Excel to Solve Statistical Problems. DOI: 10.1007/978-3-031-65449-7.
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Written exam (120 min)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	The students should bring a laptop for the exercises.
Module Components	• Lecture/exercise Data Analytics and Process Modelling • Exam Data Analytics and Process Modelling
Components to be offered in the Current Semester	**320410** Lecture/Exercise Data Analytics and Process Modelling - 4 Hours per Term **320471** Examination Data Analytics and Process Modelling

Module 14723 Management Tools

assign to: Common Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	14723	Compulsory elective

Modul Title	**Management Tools** Management-Werkzeuge
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Fien, Harald
Language of Teaching / Examination	English
Duration	2 semesters
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	In this lecture, students will gain a solid understanding of essential management tools that are commonly applied in real-world business scenarios. By exploring typical management situations—such as developing a corporate strategy, solving complex problems, making high-stakes decisions, and leading organizational change—students will learn how to select and apply appropriate tools to navigate these challenges effectively. Special emphasis is placed on identifying the soft skills required to manage such situations, including planning ability, analytical skills, implementation skills, communication skills and passion. Throughout the lecture, students will also explore how artificial intelligence (AI) can support and enhance the use of traditional management tools. From generative AI to agentic AI, the lecture demonstrates how AI-based solutions can provide valuable insights and improve managerial effectiveness. By the end of the lecture, students will be equipped not only with practical tools and frameworks but also with an understanding of the human and technological dimensions of modern management.
Contents	• Typical management situations • Required management skills • Proven management tools • Leveraging AI in the use of management tools
Recommended Prerequisites	• fundamentals in engineering and preferably power engineering
Mandatory Prerequisites	No successful enrolment for 35443 International Management.
Forms of Teaching and Proportion	Lecture - 1 hours per week per semester

	Self organised studies - 150 hours
Teaching Materials and Literature	• Literature requirements are made during the lecture.
Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	Prerequisites: • Passing learning tests that follow each lecture chapter. Final Module Examination: • eTest, 90 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	50
Remarks	• 1 SWS lectures in the winter and 1 SWS lectures in the summer semester • At the end of the lecture period in the winter and summer semesters there is one attendance day each (the exact dates will be announced during the lecture). • As the lecture has a limited number of participants, self-registration is possible during the usual periods in accordance with the general examination and study regulations until the participant limit is reached. • Participants have to register in Moodle, too.
Module Components	• Lecture Management Tools • Examination Management Tools
Components to be offered in the Current Semester	**320260** Lecture International Management - 1 Hours per Term **320286** Examination International Management

Module 11191 EMC in Electrical Power Installations

assign to: Modules in Power Systems
Studienrichtung / Vertiefung:Elektroenergietechnik

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11191	Compulsory elective

Modul Title	**EMC in Electrical Power Installations** EMV in elektrischen Anlagen
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Schenk, Mario
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Students will get a deeper understanding of possible interferences in power systems and will be able to design a EMC compatible layout in large scale power installations and systems
Contents	Electromagnetic environment (high frequency impulse fields, lightning impulse overvoltages, switching impulses, low and medium frequency interferences), EMC design criteria (protection against direct lightning stroke, potential grounding, screening, overvoltage protection,filters), EMC system planning (zone concept, interface definition) EMC measuring and testing technique
Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Script
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Written examination, 90 minutes
Evaluation of Module Examination	Performance Verification – graded

Limited Number of Participants	none
Remarks	• The seminar will include exercises, practical training and homeworks • another registration for this module in moodle • different forms of teaching are announced in moodle
Module Components	• EMC in Electrical Power Installations (lecture/seminar)
Components to be offered in the Current Semester	**320207** Lecture/Seminar EMC in Electrical Power Installations - 4 Hours per Term **320272** Examination EMC in Electrical Power Installations

Module 11192 Medium- and Low-Voltage Technology

assign to: Modules in Power Systems
Studienrichtung / Vertiefung:Elektroenergietechnik

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11192	Compulsory elective

Modul Title	**Medium- and Low-Voltage Technology** Betriebsmittel der Mittel- und Niederspannungstechnik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Dr.-Ing. Pfeiffer, Klaus
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The aim of the lecture is to enable students to dimension equipment for medium and low voltage technology and to select it correctly according to the conditions of use. For this purpose, it will be also taught which calculations are required for this.
Contents	• Transformers • Switchgears • Substations • Cables and overhead lines • Switching devices • Basics in symmetrical fault calculation • Calculation of relevant stress parameters to the equipment • Project work (including s.c.-calculation, cable selection and rating of switchgears)
Recommended Prerequisites	Module 11196 *„Introduction in Electrical Power“*
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Script
Module Examination	Final Module Examination (MAP)

Assessment Mode for Module Examination	The exam can be in written form or as an oral exam. • For a written examination: 90 minutes duration • For an oral exam: 30 min duration Written and oral exams can be conducted in personal attendance or in an online format. Until the end of the first three weeks of lectures it will be announced, if the examination will be offered in written or oral form.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Medium- and Low-Voltage Technology (lecture/seminar)
Components to be offered in the Current Semester	**320101** Lecture/Seminar Medium- and Low-Voltage Technology - 4 Hours per Term **320171** Examination Medium- and Low-Voltage Technology

Module 11199 Auxiliary Power Supply of the Power Plant

assign to: Modules in Power Systems
Studienrichtung / Vertiefung:Elektroenergietechnik

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11199	Compulsory elective

Modul Title	**Auxiliary Power Supply of the Power Plant** Elektrische Eigenbedarfsversorgung von Kraftwerken
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Dr.-Ing. Pfeiffer, Klaus
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	Students have in-depth knowledge of auxiliary networks in power plants. They are able to recognise interactions with other subject areas and evaluate cross-disciplinary topics. In this context, the students recognise the interactions between selective protection in auxiliary networks, network topologies, system design and rating of the electrical equipment They are able to independently solve and evaluate application-oriented tasks and problems.
Contents	• Requirements to the auxiliary system • Basic layout, voltage levels and rating depending on power plant type and generator capacity • Redundancy concepts • DC power supply and uninterruptible power supply concepts, emergency generators • M.V.- and L.V.-switchgears in auxiliary networks including transformers, drives, adjustment drives • Selective protection in auxiliary networks • Active and reactive power control of generators, frequency control, static and dynamic stability, generator protection • Transfer concepts
Recommended Prerequisites	• Basic understanding in electrical engineering • Module 11192 *"Medium- and Low-Voltage Technology"*
Mandatory Prerequisites	none

Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Script
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	The exam can be in written form or as an oral exam. For a written examination: 90 minutes duration For an oral exam: 30 min duration Written and oral exams can be conducted in personal attendance or in an online format.Until the end of the first three weeks of lectures it will be announced, if the examination will be offered in written or oral form.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Auxiliary Power Supply of the Power Plant (lecture) • Auxiliary Power Supply of the Power Plant (seminar)
Components to be offered in the Current Semester	No assignment

Module 11473 Switching Technologies

assign to: Modules in Power Systems
Studienrichtung / Vertiefung:Elektroenergietechnik

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11473	Compulsory elective

Modul Title	**Switching Technologies** Grundlagen der Schalttechnologien
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Heinrich, Christian
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Students know the operating principles of various switching technologies used for power engineering. This covers switching in vacuum, switching in gases and power electronics including the switching devices and its characteristics. Students will also get an overview of application in industrial plants and power grids.
Contents	• Definitions and classification of switching devices • Requirements for switching elements • Vacuum switching chamber and ist characteristics • Power electronic elements and ist static and dynamic behaviour • other switching technologies • Application of vacuum switching tubes in circuit breakers • Circuit breaker application in power grids • Converterdesigns • Converter and ist applications
Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 3 hours per week per semester Exercise - 1 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• Script A list of recommanded literature will be provided during the first course.

Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Written examination, 90 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Switching Technologies (lecture/exercis)
Components to be offered in the Current Semester	**320540** Lecture/Exercise Switching Technologies - 4 Hours per Term **320580** Examination Switching Technologies

Module 11493 Calculation of Grids with Renewable Sources

assign to: Modules in Power Systems
Studienrichtung / Vertiefung:Elektroenergietechnik

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11493	Compulsory elective

Modul Title	**Calculation of Grids with Renewable Sources** Netzberechnung mit erneuerbaren Quellen
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Dr.-Ing. Pfeiffer, Klaus
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	Students have in-depth knowledge of basics in grid calculation and corresponding computational methods. They are able to recognise interactions with other subject areas and evaluate cross-disciplinary topics. Students acquire the prerequisites to independently solve application-oriented tasks. They are able to identify and apply the correct solution strategy and methodology for practically occurring problems. Basic network calculation methods are confidently mastered at the end of this course.
Contents	• Symmetrical and asymmetrical three-phase system • Transformation methods with focus on symmetrical components • Neutral point treatment • Symmetrical impedances and equivalent circuits • Calculation of asymmetrical fault currents • Nodal voltage method • Mesh-current method • Overview about software solutions in the field of grid calculation • Diverse exercises for manual calculations for given grid layouts
Recommended Prerequisites	Module *"Medium- and Low-Voltage Technology"*
Mandatory Prerequisites	None
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester

	Self organised studies - 120 hours
Teaching Materials and Literature	• Script • Reference books about power supply (Herold)
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	The exam can be in written form or as an oral exam. • For a written examination: 90 minutes duration • For an oral exam: 30 min duration Written and oral exams can be conducted in personal attendance or in an online format.Until the end of the first three weeks of lectures it will be announced, if the examination will be offered in written or oral form.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	None
Module Components	• Calculation of Grids with Renewable Sources (lecture/seminar)
Components to be offered in the Current Semester	No assignment

Module 11750 Power System Operation

assign to: Modules in Power Systems
Studienrichtung / Vertiefung:Elektroenergietechnik

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11750	Compulsory elective

Modul Title	**Power System Operation** Systemführung von Elektroenergienetzen
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Malekian Boroujeni, Kaveh
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	Students will gain a deep understanding of power system stability. A general overview of power systems, including current trends, will be presented. Students will acquire a basic understanding of the influence of new trends on power systems, with a focus on renewable energies and inverter-interfaced storage systems. Additionally, students will become familiar with some well-known stability events from practical experience.
Contents	• Overview of power systems • Current trends in power systems • Overview of power system stability • Frequency stability • Voltage stability • Rotor angle stability • Stability events from practical experience
Recommended Prerequisites	Knowledge: • Module *11493 Calculation of Grids with Renewable Sources* • Module *35409 Power Automation* • Module *35436 Power Electronic Applications in High Voltage Grids* • Module *11696 Generators and Large Drives* • Module *11196 Introduction in Electrical Power*
Mandatory Prerequisites	No successful participation in associated phase-out module *11193 Power System Operation.*
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester

	Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Script
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Coursework with the corresponding presentation. Depending on the actual number of participants, the presentation topics will be given as group work or as individual presentations. The defined presentation duration is approx. 20 minutes, followed by a discussion and Q&A session. (20%) • Written examination, 80 minutes OR oral examination, 30 minutes (80%) Within the first three weeks of the semester it will be announced, whether the examination will be offered in written or oral form.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	18
Remarks	• ***Module with limited number of participants – Registration two weeks prior to the commencement of lectures!***
Module Components	• Power System Operation (lecture) • Power System Operation (seminar)
Components to be offered in the Current Semester	**320282** Examination Power System Operation

Module 13294 Control Technology for Processes and Networks

assign to: Modules in Power Systems
Studienrichtung / Vertiefung:Elektroenergietechnik

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13294	Compulsory elective

Modul Title	**Control Technology for Processes and Networks** Leittechnik für Prozesse und Netze
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Schiffer, Johannes
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The students get some advanced knowledge about applications, tasks and technical equipment of Process Control Systems (PCS) and Network Control Systems (NCS) with the focus on power grids. The students are able to describe concentrated and distributed systems of process and network control technology and to project and configure them for an application. Tasks from the process and automation level up to the operating and visualization level are included. This requires the application of interdisciplinary knowledge. In theoretical and practical exercises, the students are enabled to solve detailed tasks of signal and information processing and visualization. The exercises promote both, independent work in preparation and jointly exchange in technical discussions.
Contents	Terms and definitions for modern control systems and the primary processes (with the focus on power grids). A short view to the history. Structure and parts of modern control systems: Real time units, stations for operation and visualisation, communication buses, analog and digital signal processing and informations, sensors and actors, computeraided design and programming, project management and documentation. Basic and advanced tasks of modern control systems: control, stabilisation, safety, visualisation and operation, reporting and optimization (important for power grids: generation and distribution management). View to the future: Smartgrids
Recommended Prerequisites	none

Mandatory Prerequisites	No successful participation in Modul 35416 Prozessleitsysteme.
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Actual informations in the lectures. Scripts and working materials are available.
Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	Prerequisite: • short tests during the semester Final Module Examination: • written examination at the end of the semester (90 minutes) Printed and written materials like scripts or books are allowed. For possible calculations a non-programmable calculator is allowed.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	Lectures - 2 hours per week per semester Exercises - 2 hours per week per semester Self organised studies -120 hours
Components to be offered in the Current Semester	**320645** Lecture Control Technology for Processes and Networks - 2 Hours per Term **320646** Exercise Control Technology for Processes and Networks - 2 Hours per Term **320679** Examination Control Technology for Processes and Networks

Module 11221 Fundamentals in Power Electronics

assign to: Modules in Power Electronics and Drive Systems
Studienrichtung / Vertiefung:Elektroenergietechnik

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11221	Compulsory elective

Modul Title	**Fundamentals in Power Electronics** Grundlagen der Leistungselektronik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Möhlenkamp, Georg
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Students learn to understand the functional principle of power electronics, their specific components, control structures and the characteristic behaviour. They are able to find suitable concepts and define components and auxiliaries for power converters.
Contents	• Definition of power electronics • Components and their static and transient behaviour • Circuit topologies as grid commutated converter • Self commutated converter • Dc-dc-converter • Resonant and quasi-resonant converter • Single and three phase applications • Characteristic values of components and topologies • Cooling • Passive components and filters • Firing • Driver and protection devices • Pulse-width-modulation • Simulation tools
Recommended Prerequisites	Fundamentals in electrical engineering
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 1 hours per week per semester Practical training - 1 hours per week per semester

	Self organised studies - 120 hours
Teaching Materials and Literature	will be given in lecture
Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	**Prerequisite:** • Successful completion of the laboratory work **Final Module Examination:** • Written examination, 90 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	The seminar contains a mixture of exercises, laboratory tests and homework.
Module Components	• Fundamenatls in Power Electronics (lecture/seminar/laboratory)
Components to be offered in the Current Semester	**320552** Practical training Fundamentals in Power Electronics - 1 Hours per Term **320551** Lecture/Seminar Fundamentals in Power Electronics - 3 Hours per Term **320576** Examination Fundamentals in Power Electronics

Module 11496 Research Seminar in Power Electronics

assign to: Modules in Power Electronics and Drive Systems
Studienrichtung / Vertiefung:Elektroenergietechnik

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11496	Compulsory elective

Modul Title	**Research Seminar in Power Electronics** Forschungsseminar Leistungselektronik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Möhlenkamp, Georg
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	On special announcement
Credits	6
Learning Outcome	At the end of the module the student is able to: • analyse advanced topics in power electronics • discuss and evaluate recent developments • present a selected topic • write a research or review report
Contents	Current selected research topics in the field of: • power electronics for high-voltage networks, • power electronics for e-cars, • design of energy efficient, high performance drives • optimization of complex drive systems
Recommended Prerequisites	• Urgently recommended: module 35436 *Power Electronic Applications in High Voltage Grids* • Urgently recommended: module 35437 *Power Electronic Applications in Drive Systems*
Mandatory Prerequisites	Successful participation in module: • 11221 - Fundamentals in Power Electronics
Forms of Teaching and Proportion	Seminar - 4 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Literature is depending from the research topic.
Module Examination	Continuous Assessment (MCA)

Assessment Mode for Module Examination	• Oral presentation and discussion (50%), ca. 15 min. • Written report (50%), ca. 20 pages At least 75% are required to pass the module successfully.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	None
Module Components	• Research Seminar in Power Electronics (seminar)
Components to be offered in the Current Semester	**320560** Seminar Research Seminar in Power Electronics - 4 Hours per Term

Module 11696 Generators and Large Drives

assign to: Modules in Power Electronics and Drive Systems
Studienrichtung / Vertiefung:Elektroenergietechnik

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11696	Compulsory elective

Modul Title	**Generators and Large Drives** Generatoren und große Antriebe
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Möhlenkamp, Georg
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	At the end of the module, students are able to: • understand the working principals and design criteria of large generators and drives, • analyze and evaluate the operation of generators and drives in electrical networks with conventional and renewable power generation plants
Contents	• Basics of synchronous generator operation • Basics of induction generator at grid operation • Basics of doubly fed asynchronous generator operation • Requirements of transmission and distribution grids • Conventional power generation plants and generators • Renewable power plants and their respective generators
Recommended Prerequisites	• Fundamentals in Electrical Machines • Fundamentals in Power Electronics
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 3 hours per week per semester Exercise - 1 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Will be given in class
Module Examination	Final Module Examination (MAP)

Assessment Mode for Module Examination	• Written examination, 90 minutes **OR** • Oral examination, 30 minutes In the first lecture it will be announced, if the examination will be offered in written or oral form.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	None
Module Components	• Generators and Large Drives (lecture) • Generators and Large Drives (exercise)
Components to be offered in the Current Semester	**320550** Lecture/Exercise Generators and Large Drives - 4 Hours per Term **320574** Examination Generators and large drives

Module 13951 Project Laboratory Control and Network Control Technology

assign to: Modules in Power Electronics and Drive Systems
Studienrichtung / Vertiefung:Elektroenergietechnik

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13951	Compulsory elective

Modul Title	**Project Laboratory Control and Network Control Technology** Projektpraktikum Regelungs- und Netzleittechnik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Schiffer, Johannes
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	After completion of this module, students should be able to: • Apply modern methods of control systems and network control technology to emerging research and development challenges in a core engineering domain, such as power system operation, microgrids, grid integration of renewable generation, robotics or multi-agent systems; • Define an overall R&D project design objective including technical specifications; • Develop a work plan suitable to achieve the overall project task and which distributes the workload amongst all team members; • Demonstrate project management skills including time planning, team work, working to deadlines and producing deliverables; • Demonstrate creativity, innovation, independence and technical competence by implementing the project proposal, delivering the design and development work as specified in the project plan; • Demonstrate improved proficiency in written and oral communications; • Understand how to make use of technical literature and other information sources.
Contents	In the project laboratory groups of two to four students are involved in the joint organization and delivery of a R&D engineering project in the areas of control systems and network control technology. The project topics are suggested by the module leader (and possible further project supervisors) based on current research and development activities in

	the abovementioned areas. Hence students are provided with a unique hands-on experience in the application of modern control systems and network control technology methods to meet emerging technological challenges. In contrast to conventional laboratory modules, students will only be provided with the project task and will have to develop independently their own plan of work and distribute the work load amongst the different team members. Therefore each team member is responsible for the success of the whole group. The supervision of the project laboratory mainly consists of consultation and feedback on the project design, organization and implementation through regular meetings at fixed times. Necessary technical devices and reading material as well as data sheets will be provided.
Recommended Prerequisites	Scientific curiosity and interest in application-oriented research. Depending on the specific project topic good knowledge of some of the following topics is helpful: control systems fundamentals, Matlab/ Simulink, C/C++, hardware-oriented programming of microcontrollers, communication systems and network control technology.
Mandatory Prerequisites	No successful participation on module *12893 - Project Laboratory Control and Network Control Technology*
Forms of Teaching and Proportion	Seminar - 2 hours per week per semester Study project - 120 hours Self organised studies - 30 hours
Teaching Materials and Literature	None
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Project report, 15-25 pages (70%) • Oral presentation ~15 min. (20%) • Brief oral question and answer session, 15 min. (10%)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	None
Module Components	Seminar and Project "Project Laboratory Control and Network Control Technology"
Components to be offered in the Current Semester	No assignment

Module 13952 Lab Control Engineering

assign to: Modules in Power Electronics and Drive Systems
Studienrichtung / Vertiefung:Elektroenergietechnik

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13952	Compulsory elective

Modul Title	**Lab Control Engineering** Labor Regelungstechnik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Dr.-Ing. Rau, Uwe
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	The students deepen the basic and advanced knowledge of control engineering by applying it to real laboratory experiments and simulated processes. The students are able to reflect on the relationships between modelling, design and practical implementation and to assess the real results in a well-founded manner. With the help of preparatory tasks and experimental instructions, they can develop their own questions and propose justified adjustments to the standard methods of control engineering. The students are able to work together in a group and solve tasks together. On the other hand, independence in the development and application of subject-specific knowledge is encouraged.
Contents	Laboratory experiments with tasks from mechanical engineering, electrical engineering and process engineering: Analysis and controller design in the time and frequency domain, state models, digital control, use of the Matlab/Simulink software package.
Recommended Prerequisites	Ready-to-use knowlegde of the Module 11494 Control Engineering 1 (or similar courses).
Mandatory Prerequisites	No successfull completion of module *35463 - Labor Regelungstechnik*
Forms of Teaching and Proportion	Laboratory training - 4 hours per week per semester Self organised studies - 120 hours per week per semester
Teaching Materials and Literature	Lecture and exercise scripts, instructions of the experiments

Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	There will be 5-7 experiments (the number will be announced at the beginning of the course). Each laboratory experiment includes: • the preparation (5-10 sheets of paper in the self-study time), • a written test (15 min in attendance time), • the execution (approx. 165 min in attendance time) and • the evaluation (10-15 sheets of paper in the self-study time). Points are awarded for the individual performances. They are distributed as follows: • Preparatory tasks 30%, • Written test 10%, • Execution and protocol 60%. The module grade is calculated on the basis of the total points achieved in the semester. The module is passed (grade 4.0) if 50% of the total points have been achieved.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	None
Module Components	320619 "Laborpraktikum Regelungstechnik".
Components to be offered in the Current Semester	No assignment

Module 14514 Lecture Series Hybrid-Electric Propulsion

assign to: Modules in Power Electronics and Drive Systems
Studienrichtung / Vertiefung:Elektroenergietechnik

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	14514	Compulsory elective

Modul Title	**Lecture Series Hybrid-Electric Propulsion** Ringvorlesung Hybrid-Elektrische Antriebe
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. rer. nat. Enghardt, Lars
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	The module will give an overview into selected topics referring to hybrid-electric propulsion systems from experts in the field - including current research from DLR, CHESCO and BTU, plus invited guests. Each lecture will cover a specific topic chosen by the corresponding lecturer and will give deep insights into current problems and solutions concerning hybrid-electric propulsion systems and their components. Students will thus require expert knowledge on selected, very specific topics from current research areas with suggestions on how to obtain additional (background) information as well as contacts to representatives from academia and industry.
Contents	The lectures are given by experienced researchers from different research institutions. A full list of lectures will be presented at the beginning of the summer semester.
Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Study project - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	The lecture slides will be made available after each lecture if the lecturer agrees and the intellectual property rights situation permits.
Module Examination	Continuous Assessment (MCA)

Assessment Mode for Module Examination	• Students will write a 15 page report on one topic of their choice (70 %) to be chosen from a provided preselection list and • a corresponding presentation of approximately 30 minutes at the end of the semester (30 %).
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	VL, PROJ Lecture Series Hybrid-Electric Propulsion
Components to be offered in the Current Semester	No assignment

Module 35436 Power Electronic Applications in High Voltage Grids

assign to: Modules in Power Electronics and Drive Systems
Studienrichtung / Vertiefung:Elektroenergietechnik

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	35436	Compulsory elective

Modul Title	**Power Electronic Applications in High Voltage Grids** Leistungselektronik in Hochspannungsanlagen
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Möhlenkamp, Georg
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	Students get a deeper view into the specific items of power electronics in grid applications. They know typical components, applications and control strategies for designing and use of devices in higher voltage and power levels.
Contents	• High voltage and high current power electronics components • Cooling principles • Serial and parallel connection of components • Multiphase and multilevel converter topologies • Control structures for grid connection and parallel operation • Applications like HVDC and FACTS
Recommended Prerequisites	• Urgently recommended: module 11221 *Fundamentals in Power Electronics* • Control Engineering
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Will be given in lecture
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Oral examination, 30 minutes

Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Power Electronic Applicatins in High Voltage Grid (lecture) • Power Electronic Applications in High Voltage Grid (exercise)
Components to be offered in the Current Semester	**320575** Examination Power Electronic Applications in High Voltage Grid

Module 35437 Power Electronic Applications in Drive Systems

assign to: Modules in Power Electronics and Drive Systems
Studienrichtung / Vertiefung:Elektroenergietechnik

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	35437	Compulsory elective

Modul Title	**Power Electronic Applications in Drive Systems** Leistungselektronik in Antriebssystemen
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Möhlenkamp, Georg
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	Students learn the specific items of power electronics in drive applications. They know the typical topologies, power circuit and control structures and can rate and design a drive converter.
Contents	• Voltage source inverter systems • Converter and control design for dc drives • Reversing operation dc drives • Three-phase asynchronous and synchronous drives • Direct torque control and vector control • Pulse-width-modulation for drive converter • Drives with recuperation • Dimensioning of converter systems
Recommended Prerequisites	• Urgently recommended: module 11221 *Fundamentals in Power Electronics* • Electrical Machines • Control Engineering
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 1 hours per week per semester Laboratory training - 1 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Will be given in lecture

Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Written examination, 90 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Power Electronic Applications in Drive Systems (lecture) • Power Electronic Applications in Drive Systems (exercise) • Power Electronic Applications in Drive Systems (laboratory)
Components to be offered in the Current Semester	**320577** Examination Power Electronic Applications in Drive Systems

Module 13169 Gas Cleaning

assign to: Modules in Power Generation from Fossil Fuels and Thermodynamics
Studienrichtung / Vertiefung:Energieerzeugung durch fossile und erneuerbare Energieträger

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13169	Compulsory elective

Modul Title	**Gas Cleaning** Gasreinigung
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Riebel, Ulrich
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	Student will be able to: • understand working principle of diverse devices for the control of gaseous emissions. • understand relations between apparatus or process design and performance. • select and combine appropriate technologies for the reduction of emissions in specific situations.
Contents	Introduction – applications of gas cleaning in industrial processes and pollution control. Historical development and legislation. Various topics of particle separation and dust control. Characterization of particle size distributions and separation efficiency. Gravitational and inertial particle separators. Filters. Electrostatic precipitators. Wet scrubbers. Droplet separation. Combinations of separators. Separation of acid gases (HCl, HX, SO2/SO3 and others) Reduction of NOx, SNCR and SCR processes. Reduction of VOCs. Special Topics (Mercury, PAHs, Dioxins).
Recommended Prerequisites	Students should have a bachelor´s degree in engineering science or physics
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 3 hours per week per semester Laboratory training - 1 hours per week per semester Self organised studies - 120 hours

Teaching Materials and Literature	• N.A. Fuchs: The Mechanics of Aerosols (Dover 1965) • W. Strauss: Air Pollution Control, (WILEY 1971) • W. Hinds, Aerosol Technology (Wiley 1982,) • F. Löffler: Staubabscheiden (G. Thieme 1988) • JPK Seville: Gas Cleaning in Demanding Applications (Springer 1997) • K. Spurny: Advances in Aerosol Filtration (CRC Press, 1998) • K. Görner, K. Hübner: Gasreinigung und Luftreinhaltung (Springer 2002)
Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	**Prerequisite for Final Module Examination:** • The laboratory report (ca. 10 pages) is a prerequisite for admission to the final module examination. **Final Modul Examination:** • Oral (30 min/participant) **OR** • Written (1.5 hrs) examination Kind of final module examination will be defined when the module starts.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	25
Remarks	none
Module Components	• 230301 Gas CleaningExamination Gas Cleaning
Components to be offered in the Current Semester	**360372** Examination Gas Cleaning

Module 14145 Electrochemical and Chemical Energy Storage and Conversion

assign to: Modules in Power Generation from Fossil Fuels and Thermodynamics
Studienrichtung / Vertiefung:Energieerzeugung durch fossile und erneuerbare Energieträger

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	14145	Compulsory elective

Modul Title	**Electrochemical and Chemical Energy Storage and Conversion** Elektrochemische und chemische Energiespeicherung und -wandlung
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Mauß, Fabian
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	The lecture deals with electrochemical and chemical processes which are important for renewable energy storage and conversion. The lecture incorporates recent research from the Energy Innovation Center of BTU Cottbus-Senftenberg. Students acquire in-depth knowledge of thermodynamic processes, the reaction mechanisms of electro-catalysis, turbulent combustion of fuels and measurement devices to characterize surface and gas phase reactions. They are familiar with the simulation of the teached processes. Students gain in-depth knowledge of the subject area and are able to make scientifically sound judgments.
Contents	Introduction to electro-chemical energy storage and conversion • Power-to-X-to-Power energy and substance cycles • Energy balances and efficiencies • environmental impact … Electrochemistry • Fundamentals • Electrode reaction and Butler-Volmer equation • Impedance spectroscopy • Electrolysis • Lithium-Ion-Battery • Simulation Synthesis & Conversion • Heterogeneous catalysis

	• Reactor types • Power-to-X-to-Power processes • Industrial applications • Surface spectroscopy • Modelling & Simulation Kinetics & Spectroscopy • Transition State Theory (TST), Thermodynamic Formulation of TST • Unimolecular Rate Theory Beyond Lindemann Mechanism • Introduction to Spectroscopy and Laser Diagnostics for Gases (diatomic/polyatomic Spectra, quantitative emission and absorption, LIF and its applications).
Recommended Prerequisites	• Thermodynamics • Heat and mass transfer • Chemistry
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Teaching materials: • Power point presentations
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Written examination, 90 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	None
Module Components	Lecture Seminar
Components to be offered in the Current Semester	**320779** Examination Electrochemical and Chemical Energy Storage and Conversion

Module 35449 Power Plant Technology 1

assign to: Modules in Power Generation from Fossil Fuels and Thermodynamics
Studienrichtung / Vertiefung:Energieerzeugung durch fossile und erneuerbare Energieträger

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	35449	Compulsory elective

Modul Title	**Power Plant Technology 1** Kraftwerkstechnik 1
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. rer. nat. Röntzsch, Lars
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The objective of this course is to make students learn about various power generation processes and technologies. The course will cover the fundamental thermodynamic power cycles viz. Rankine cycle, Brayton cycle and various ways to improve cycle efficiency and associated practical challenges. With this theoretical foundation of power generation technologies, further instructions will be focused on fuels and combustion systems and the environmental impacts originating from power plant emissions and their mitigation strategies. Students will be able to develop theoretical and practical understanding of the power generation by various energy sources. They will be able to comprehend physical processes, operating principle and design of conventional and renewable power plants.
Contents	**Introduction to power generation:** Introduction, primary energy sources, energy conversion, steam power plant, nuclear power plants, hydropower plants, solar power plants, thermal energy, wind power plants, waste-to-power generation, geothermal power plants, biomass-based power plants, hydrogen and fuel cells, world energy statistics **Steam power plants:** Introduction, phases of a pure substance, construction of p-v, T-s, and h-s diagrams, water-steam tables, Carnot cycle, Rankine cycle, reheating and regeneration, feedwater heaters, supercritical pressure cycle, deaerator, binary vapour cycle, combined cycle plants, economics of power generation **Gas power plants:** Introduction, classification of gas turbine plants, gas power cycle, analysis of the Joule-Brayton cycle, air standard cycle assumptions, regeneration, reheating and intercooling, combined gas and steam power cycle

	Fuels and combustion: Introduction, classification of fuels, solid fuels, analysis of coal, gaseous fuels, liquid fuels, combustion of fuels, composition of fossil fuels, combustion stoichiometry, air-fuel ratio, excess air, mole and mass flow balance, incomplete combustion, combustion energy, adiabatic flame temperature, flame types, coal combustion process **Combustion systems:** Introduction, combustion systems for solid fuels, fixed bed combustion, bubbling fluidized bed combustion (BFBC), circulating fluidized bed combustion (CFBC), pressurized fluid bed combustion (PFBC), pulverized coal (PC) combustion, combustion systems for gaseous fuels **Power plant emissions and their mitigation:** Emissions in power plants, environmental impact assessment (EIA), flue gas cleaning methods, particulate matters and their cleaning methods, sulfur compounds (SO_x), methods for SO_x reduction, nitrogen oxides (NO_x), methods for NO_x reduction, mitigation options of CO_2 emissions, carbon capture technologies (CCT)
Recommended Prerequisites	• Fundamental and good knowledge and coherent understanding of technology, physics, chemistry, and mathematics (Bachelor's level) • Fundamental and good knowledge of thermodynamics and heat transfer (Bachelor's level)
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	The course documents are provided in the learning management system Moodle.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Mid-term written exam (60 min, worth 50% of the total module grade) • Final written exam (60 min, worth 50% of the total module grade)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	Lectures, exercises, exams
Components to be offered in the Current Semester	**320451** Lecture/Exercise Power Plant Technology 1 - 4 Hours per Term **320480** Examination Power Plant Technology 1

Module 35450 Power Plant Technology 2

assign to: Modules in Power Generation from Fossil Fuels and Thermodynamics
Studienrichtung / Vertiefung:Energieerzeugung durch fossile und erneuerbare Energieträger

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	35450	Compulsory elective

Modul Title	**Power Plant Technology 2** Kraftwerkstechnik 2
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. rer. nat. Röntzsch, Lars
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	Students will be able to understand the engineering design, operation and maintenance aspects for the components of thermal power plants. They will be able to comprehend various power plant related emissions and their mitigation strategies used.
Contents	**Fundamentals of heat transfer:** Heat transfer mechanisms, Fourier's law, Newton's law of cooling, radiative heat transfer, general heat conduction equations, boundary and initial conditions, heat transfer by conduction cases – plane wall, composite wall, cylinder, concentric cylinder, sphere **Heat exchangers:** Introduction to heat exchangers, classification, LMTD method, effectiveness-NTU method, fouling factor, overall heat transfer coefficient, shell and tube heat exchangers – construction, parts, standards and codes, fluid stream allocations, thermo-hydraulic analysis, KERN method, demonstration by example of KERN method **Pumps:** Introduction to pumps, classification, positive displacement pumps, rotodynamic pumps, characteristics of positive displacement pumps, centrifugal pumps, heads in centrifugal pumps, pump power, efficiency, characteristic curves of centrifugal pumps, priming, cavitation, NPSH, pump operation in parallel and series, sizing of pumps – demonstration by example **Steam generators:** Fundamentals of steam generators, major components, classification, fire tube boilers, water tube boilers, components of water tube boilers, heat absorption in water tube boilers, forced circulation boilers, natural

	circulation boilers, once-through boilers, economizers, superheaters, air preheater, de-superheating and attemperator, supercritical boilers, ultra-supercritical technology, maintenance of steam generators **Introduction to compressible flow and steam turbines:** Fundamentals of compressible flow, Mach number, compressibility, stagnation properties, one-dimensional isentropic flow, nozzles, diffusers, mass flow through converging nozzle, flow in steam nozzles, nozzle efficiency, basics of turbines, classification of steam turbines, impulse and reaction turbines, staging, degree of reaction, compounding, condensing and non-condensing turbines, maintenance of steam turbines **Steam condensers and cooling water system:** Fundamentals of steam condensers, major components, condenser types, direct contact condensers, surface condensers, vacuum in the condenser, vacuum efficiency, sources of air in condensers, condenser efficiency, cooling systems in power plants, circulation, cooling towers, components of cooling towers, performance parameters of a cooling tower, natural and mechanical draft cooling towers **Power plant emissions and their mitigation:** Emissions in power plants, environmental impact assessment (EIA), flue gas cleaning methods, particulate matter and its cleaning methods, sulfur compounds (SO_x), methods for SO_x reduction, nitrogen oxides (NO_x), methods for NO_x reduction, mitigation options for CO_2 emissions, carbon capture technologies (CCT)
Recommended Prerequisites	• Module 35449 "Power Plant Technology 1" • Fundamental and good knowledge and coherent understanding of technical thermodynamics, heat transfer, fluid mechanics, engineering mechanics, and inorganic chemistry (Master's level)
Mandatory Prerequisites	No successful participation in associated phase-out module *35404 Kraftwerkstechnik II*.
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	The course materials are provided in the learning management system Moodle.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Mid-term written exam (60 min, worth 50% of the total module grade) • Final written exam (60 min, worth 50% of the total module grade)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	Lectures, exercises, exams
Components to be offered in the Current Semester	**320481** Examination Power Plant Technology 2

Module 44108 Thermal Process Engineering and Equilibrium Thermodynamics

assign to: Modules in Power Generation from Fossil Fuels and Thermodynamics
Studienrichtung / Vertiefung:Energieerzeugung durch fossile und erneuerbare Energieträger

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	44108	Compulsory elective

Modul Title	**Thermal Process Engineering and Equilibrium Thermodynamics** Thermische Prozesse und Gleichgewichtsthermodynamik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Mauß, Fabian
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The module provides knowledge about equilibrium thermodynamics and its important technical applications. Based on the fundamentals in thermodynamics of mixtures, the student will learn how to calculate phase equilibria of real multicomponent systems. Upon successful completion of this course, students will be able to calculate equilibrium processes as absorption and extraction. The apparatuses for this separation processes can be dimensioned.
Contents	• pvt behaviour of real fluids • Characterization of mixtures • State laws (virial equations, cubic state laws, generalized state laws) • Activity coefficient models (Wilson, NRTL, UNIQUAC …) • Steam/liquid, liquid/liquid, and solid liquid equilibriums • Thermal separation: absorption
Recommended Prerequisites	Strongly recommended: • Knowledge in mathematics • Physics, thermodynamics • Fundamentals in thermal process engineering
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours

Teaching Materials and Literature	• Lecture handouts, formulary, exercise materials available on Moodle • Coulson, John M.: Coulson & Richardson's chemical engineering volume 2. Butterworth-Heinemann, Oxford 2002. • Felder, Richard M.; Rousseau, Ronald: Elementary principles of chemical processes. Wiley, New York 2000. • Reid, Robert; Prausnitz, John; Pohling, Bruce: The properties of gases and liquids. McGraw Hill, New York 1987. • Seader, J. D.; Henley, E.J.: Separation Process Principles. Wiley-VCH, Chichester 2006. • Hillert, Mats: Phase equilibria, phase diagrams and phase transformations. Cambridge Univ. Press, Cambridge 2008.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• 10 calculation exercises (50%), • oral test, 30 min (50%)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Lecture Thermal Process Engineering and Equilibrium Thermodynamics • Exercise Thermal Process Engineering and Equilibrium Thermodynamics
Components to be offered in the Current Semester	**320704** Lecture Thermal Process Engineering and Equilibrium Thermodynamics - 2 Hours per Term **320705** Exercise Thermal Process Engineering and Equilibrium Thermodynamics - 2 Hours per Term **320775** Examination Thermal Process Engineering and Equilibrium Thermodynamics

Module 44407 Technical Combustion

assign to: Modules in Power Generation from Fossil Fuels and Thermodynamics
Studienrichtung / Vertiefung:Energieerzeugung durch fossile und erneuerbare Energieträger

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	44407	Compulsory elective

Modul Title	**Technical Combustion** Technische Verbrennung
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Mauß, Fabian
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	At the end of the module the student are able to describe the chemistry and physics of combustion processes is the aim of the module. Furthermore they can apply their knowledge about laminar and turbulent premixed and diffusion flames.
Contents	The module will analyze the thermodynamics of combustion processes. Thereafter an introduction to chemical kinetics in combustion is given. This includes homogenous gas phase reactions, chain reactions, as well as ignition and extinction processes in homogeneous systems. The last chapter will demonstrate the technical application of the fundamental processes which have been studied in this class.
Recommended Prerequisites	**Strongly recommended:** Fundamental knowledge in mathematics and physics, themodynamics, and heat and mass transfer
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• Lecture material and exercises available on Moodle • Peters, Norbert: Turbulent Combustion. Cambridge Univ. Press, Cambridge 2000. • Warnatz, Jürgen: Verbrennung - Physikalisch-chemische Grundlagen, Modellierung und Simulation, Experimente, Schadstoffentstehung. Springer-Verlag, Berlin 2001.

- Warnatz, Jürgen; Maas, Ulrich; Dibble, Robert: Combustion - Physical and chemical fundamentals, modeling and simulation, experiments, pollutant formation. Springer-Verlag, Berlin 2006.
- Görner, Klaus: Technische Verbrennungssysteme - Grundlagen, Modellbildung, Simulation. Springer-Verlag, Berlin 1991.
- Stephen R. Turns: An Introduction to Combustion: Concepts and Applications von McGraw-Hill Higher Education, April 2011.

Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	• **Prerequisite**: • Successful completion of the computer lab including lab report (approxm. 10 pages) **Final Module Examination:** • Written examination, 90 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	• All module components will take place via Jitsi.
Module Components	• Lecture Technical Combustion • Exercise Technical Combustion
Components to be offered in the Current Semester	**320706** Lecture Technical Combustion - 2 Hours per Term **320711** Exercise Technical Combustion - 2 Hours per Term **320773** Examination Technical Combustion

Module 44430 Fundamentals in Thermal Process Engineering

assign to: Modules in Power Generation from Fossil Fuels and Thermodynamics
Studienrichtung / Vertiefung:Energieerzeugung durch fossile und erneuerbare Energieträger

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	44430	Compulsory elective

Modul Title	**Fundamentals in Thermal Process Engineering** Grundlagen der Thermischen Verfahrenstechnik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Mauß, Fabian
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	In the module the fundamentals of engineering thermodynamics will be introduced and applied to problems of energy conversion. This also includes equilibrium thermodynamics of ideal mixtures. Furthermore the fundamentals of heat and mass transfer will be teached. Both beeing important in many technical processes within energy conversion and chemical engineering. Upon successful completion of this course, students will have gained working knowledge of basic properties of thermodynamic systems, processes and cycles. Simple heat transfer problems can be solved using either similarity correlations or analytical solutions. The analogy between heat and mass transfer will be understood. The knowledge in thermodynamics and heat and mass transfer will be applied to distillation and rectification processes. In this course the fundamentals in evaluating unit operations in heat transfer and thermal separation processes are trained. The aim of the module is solving praxis relevant problems in thermal process engineering, based on knowledge in phase equilibrium, balancing and transport processes. The student will be trained to select and balance processes and equipment for thermal separation.
Contents	• Properties of thermodynamic systems • First and second law of thermodynamics • Ideal gas law and changes in state of ideal gases • Mixtures of ideal gases, humid air • Phase equilibrium vapour-liquid of ideal mixtures • Conservation of mass, species and energy • Fundamentals of heat transfer (conduction, convective heat transfer, radiation)

	• Fundamentals of mass transfer (diffusion, convective mass transfer) • Working methods and fundamentals in Thermal Process Engineering (terms, balancing, flow diagrams) • Fundamental law in thermodynamics, phase equilibrium, steam-liquid equilibrium of ideal and real mixtures) • Balancing of heat exchanger • Boil down and vaporization of aqueous solutions • Distillation/rectification • Balancing of column apparatus
Recommended Prerequisites	Strongly recommended: • Knowledge in mathematics, physics, thermodynamics
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Practical training - 3 hours Self organised studies - 117 hours
Teaching Materials and Literature	• Lecture handouts, formulary, exercise materials available on Moodle • Sonntag, Richard Edwin; Borgnakke, Claus: Fundamentals of thermodynamics. Wiley, New York 2003. • Moran, Michael J.; Shapiro, Howard N.: Fundamentals of engineering thermodynamics. Wiley, Chichester 2006. • Incropera, Frank P., De Witt, David P.: Fundamentals of heat and mass transfer. Wiley, New York 2002. • Baehr, Hans Dieter; Stephan, Karl: Heat and mass transfer. Springer, Berlin 2006. • Coulson, John M.: Coulson & Richardson's chemical engineering volume 2. Butterworth-Heinemann, Oxford 2002. • Felder, Richard M.; Rousseau, Ronald: Elementary principles of chemical processes. Wiley, New York 2000. • Seader, J. D.; Henley, E.J.: Separation Process Principles. Wiley-VCH, Chichester 2006.
Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	**Prerequisite:** • Successful completion of the practical training "rectification" including lab report **Final Module Examination:** • Written examination, 90 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	All module components will take place via Adobe Connect.
Module Components	• Lecture Fundamentals in Thermal Process Engineering • Exercise Fundamentals in Thermal Process Engineering

Components to be offered in the Current Semester	**320708** Lecture Fundamentals in Thermal Process Engineering - 2 Hours per Term **320709** Exercise/Practical training Fundamentals in Thermal Process Engineering - 2 Hours per Term **320774** Examination Fundamentals in Thermal Process Engineering

Module 13795 Market Integration of Renewable Energies and Sector Coupling

assign to: Modules in Power Generation from Renewables and Energy Storages
Studienrichtung / Vertiefung:Energieerzeugung durch fossile und erneuerbare Energieträger

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13795	Compulsory elective

Modul Title	**Market Integration of Renewable Energies and Sector Coupling** Marktintegration erneuerbarer Energien und Sektorenkopplung
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. rer. nat. Ragwitz, Mario
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The course gives a comprehensive overview of all relevant aspects of market integration of renewable energies including quantitative modelling based on the model PyPSA. Based on a detailed characterisation of the challenges of market integration the different flexibility options available within modern energy systems will be introduced and their impact on the market outcome will be assessed quantitatively. Furthermore, regulatory and policy choices will be addressed. After attending the module "Market Integration of Renewable Energies and Sector Coupling" the student will have a deeper understanding of the challenges and options of the integration of renewable energies into energy markets. Furthermore, the student will be familiar with the definition of sector coupling and the various technologies and organisational options for the integration of energy sectors. Students will understand the impact of the regulatory framework and technology choices on the market integration of renewable energies and will be able to apply methods and tools for analysis of energy markets.
Contents	• Scenarios for the development of future energy systems • Definition and challenges of market integration of renewable energies • Instruments for market-based investment decisions and dispatch of renewable energies • Technology options for the integration of energy sectors • Flexibility options on the supply and demand side and based on based on storage technologies

	• Value of flexibility at the energy market • The role of grid infrastructures for the market integration of renewable energies • Python Programming Fundamentals: Introduction to reading and writing Python code, focusing on important programming concepts necessary for energy modeling. • Introduction to simulation and optimisation techniques in energy system modelling • Methodologies for analyzing and managing datasets • Policies for renewable energy sources in the power sector
Recommended Prerequisites	Participation at • module 35303 - "Power System Economics I" and • module 35401 - "Power System Economics II" is strongly recommended
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 90 hours
Teaching Materials and Literature	• Script (slides) • Reference books • Agora Energiewende. 2018. Energiewende 2030: The Big Picture – Megatrends, Targets, Strategies and a 10-Point Agenda for the Second Phase of Germany's Energy Transition. Impulse. Berlin • IEA (2022), World Energy Outlook 2022, IEA, Paris https://www.iea.org/reports/world-energy-outlook-2022 • IEA (2011), Integration of Renewables, IEA, Paris https://www.iea.org/reports/integration-of-renewables • Winkler (2016)): Market integration of renewables in the electricity sector – impact on electricity markets and renewable support policy as well as interactions with system flexibility, Dissertation, University of Freiburg. • JRC – Joint Research Centre (2020): Towards net-zero emissions in the EU energy system by 2050 – Insights from scenarios in line with the 2030 and 2050 ambitions of the European Green Deal. EUR 29981 EN. Publications Office of the European Union, Luxembourg, doi:10.2760/081488. • Wietschel, M.; Held, A.; Pfluger, B.; Ragwitz, M. (2020): Energy integration across electricity, heating & cooling and the transport sector – Sector coupling. Fraunhofer ISI Working Paper Sustainability and Innova-tion, No. S 08/2020 • Energy sector magazines
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Written examination, 60 minutes OR oral examination, 30 minutes (the lecturer decides and informs at the beginning of the course) 60 % • 2 Seminar works including presentation (duration 15 minutes, presentation ca. 10 slides) 40 %

Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	20
Remarks	none
Module Components	• VL Market Integration of Renewable Energies and Sector Coupling • Proj Market Integration of Renewable Energies and Sector Coupling
Components to be offered in the Current Semester	**322101** Lecture Market Integration of Renewable Energies and Sector Coupling - 2 Hours per Term **322102** Seminar/Exercise Market Integration of Renewable Energies and Sector Coupling - 4 Hours per Term

Module 13926 Hydrogen and Fuel Cells

assign to: Modules in Power Generation from Renewables and Energy Storages
Studienrichtung / Vertiefung:Energieerzeugung durch fossile und erneuerbare Energieträger

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13926	Compulsory elective

Modul Title	**Hydrogen and Fuel Cells** Wasserstoff und Brennstoffzellen
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. rer. nat. Röntzsch, Lars
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Students are introduced to the complete chain of hydrogen energy technology, covering hydrogen production, storage, distribution, and utilization. Each chapter of the course explores the physico-chemical principles underlying specific hydrogen technologies, provides a detailed description of the technology (including material selection and production aspects), and illustrates its applications through practical examples. The course also incorporates exercises and a graded laboratory experiment, enhancing hands-on learning and practical application of theoretical knowledge.
Contents	1. Introduction to hydrogen and its properties 2. Hydrogen energy cycle 3. Hydrogen production 4. Hydrogen purification 5. Hydrogen storage 6. Distribution and infrastructure 7. Fuel cells 8. Hydrogen combustion 9. Hydrogen safety
Recommended Prerequisites	Good knowledge and coherent understanding of power engineering, physics, chemistry, and mathematics (Master's level)
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 3 hours per week per semester Exercise - 1 hours per week per semester

	Self organised studies - 120 hours
Teaching Materials and Literature	The course documents are provided in the learning management system Moodle. Further literature: • Compendium of Hydrogen Energy, Volumes 1-4 (Woodhead, 2015). • Hydrogen - Its Technology and Implications, Volumes 1-5 (CRC Press, 2018). • Fuel Cells and Hydrogen Production (Springer Science, 2019). • Hydrogen Energy - Challenges and Solutions for a Cleaner Future (Springer, 2019). • Hydrogen Production Technologies (Wiley, 2017). • Handbook of Hydrogen Energy (CRC Press, 2014). Hydrogen Safety (CRC Press, 2013).
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Final written exam (80 min; 75 % of final grade) • Graded laboratory experiment (entrance test (~10 min.), self-managed realisation (~80 min.) and report including evaluation of the experiments (at least 10 pages); 25 % of final grade)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	30
Remarks	none
Module Components	Lectures, exercises, laboratory experiment, exam
Components to be offered in the Current Semester	**320455** Lecture/Practical training Hydrogen and Fuel Cells - 4 Hours per Term

Module 13964 Geothermal Energy

assign to: Modules in Power Generation from Renewables and Energy Storages
Studienrichtung / Vertiefung:Energieerzeugung durch fossile und erneuerbare Energieträger

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13964	Compulsory elective

Modul Title	**Geothermal Energy** Geothermische Energie
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. rer. nat. Ragwitz, Mario
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	The module provides an overview of geothermal technologies and their application for the generation of electricity, heating & cooling and for underground thermal energy storage. The students understand the geothermal heat source, properties of the subsurface and thermal transfer mechanisms. They apply knowledge to the basic design of local heat distribution systems, the integration of low temperature geothermal heat sources and ground-source heat pumps in the energy supply systems and the use of geothermal storage options for the balancing of seasonal heating&cooling demands with asynchronous supply and demand cycles as well as the basic economic considerations of geothermal energy generation and heat network integration.
Contents	• Basic geological principles • Overview of different geothermal systems • Geothermal fluids – thermal and chemical properties • Heat transfer in the subsurface • Reservoir characterization • Design of a geothermal system • Geothermal electricity: historical development, types of power plants • Geothermal heat usage: residential heating, industrial applications • Environmental issues of geothermal energy • Geothermal heat networks • Integration of ground-source heat pumps in flexible heat supply systems • Economics of geothermal energy and heat networks / disttrict heating • Support schemes for geothermal energy and heat networks / disttrict heating

Recommended Prerequisites	Participation at module on “Fluid Dynamics” recommended
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• Script (slides) • Reference books • R. di Pippo: Geothermal Power Plants Principles, Applications, Case Studies and Environmental Impact 4th Edition, Elsevier, 2015 • George L. Danko: Model Elements and Network Solutions of Heat, Mass and Momentum Transport Processes, Springer-Verlag GmbH. 2016.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Written examination (duration 60 minutes) 60 % • 2 Seminar works (creating presentation slides) including presentation (duration 15 minutes, presentation ca. 10 slides) 40 %
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	20
Remarks	none
Module Components	• VL/Ü Geothermal Energy
Components to be offered in the Current Semester	No assignment

Module 13987 Electrical Power Generation and Integration of Wind Energy

assign to: Modules in Power Generation from Renewables and Energy Storages
Studienrichtung / Vertiefung:Energieerzeugung durch fossile und erneuerbare Energieträger

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13987	Compulsory elective

Modul Title	**Electrical Power Generation and Integration of Wind Energy** Elektrische Energieerzeugung und Integration von Windenergie
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Malekian Boroujeni, Kaveh
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Students will get a deep understand of wind energy technologies, including the basics of fundamental principles of wind turbines and their components. Principles of operation of wind turbines regarding important parameters will be introduced. Students will get a basic overview in grid integration and economics of wind turbines and will faced with advantages and disadvantages of fluctuating power infeed. A general overview about planning, operation and maintenance of wind turbines will be shown.
Contents	1. General overview about wind energy 2. Physics of wind energy, drag and lift etc. 3. Construction of wind turbines, components 4. Operation of wind turbines: wind speed, roughness, profiles 5. Power generation concepts of wind turbines 6. Grid integration 7. Planning, operation, maintenance, economics
Recommended Prerequisites	Fundamental knowledge in engineering and mathematics is beneficial.
Mandatory Prerequisites	No successful participation in **11689 Power Generation from Wind Energy**
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours

Teaching Materials and Literature	Students will be provided with slides and materials presented in the lessons. Further recommendations for literature will be announced in the first lectures.
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Written examination, 90 minutes OR • Online examination, 90 minutes OR • Oral examination, 30 minutes (The corresponding regulation for each semester will be announced in the first lecture.)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	VL + Prü Electrical Power Generation and Integration of Wind Energy
Components to be offered in the Current Semester	**320103** Lecture/Seminar Electrical Power Generation and Integration of Wind Energy - 4 Hours per Term **320170** Examination Electrical Power Generation and Integration of Wind Energy

Module 13988 Electrical Power Generation and Integration of Solar Energy

assign to: Modules in Power Generation from Renewables and Energy Storages
Studienrichtung / Vertiefung:Energieerzeugung durch fossile und erneuerbare Energieträger

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13988	Compulsory elective

Modul Title	**Electrical Power Generation and Integration of Solar Energy** Elektrische Energieerzeugung und Integration von Solarenergie
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Malekian Boroujeni, Kaveh
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Students will get an introduction into photovoltaics, including the basics of fundamental principles of fabrication and operation of solar cells. Furthermore current PV technology trends and material research towards new concepts will be discussed. Presentation of basic principles of power generation and operation of solar energy. Students will get a basic understanding in grid integration of solar energy and economics of solar energy concepts.
Contents	1. Solar insolation: Energy sources of photovoltaics 2. Photovoltaic technologies (Si-wafer based vs. thin-film PV) and solar cell materials 3. New technology trends and future concepts (e.g. floating PV) 4. Solar power generation and grid integration 5. Basic economics, installation and operation
Recommended Prerequisites	Fundamental knowledge in engineering and mathematics is beneficial.
Mandatory Prerequisites	No successful participation in **11690 Power Generation from Solar Energy.**
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours

Teaching Materials and Literature	Students will be provided with slides and materials presented in the lessons. Further recommendations for literature will be announced in the first lecture.
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Written examination, 90 minutes OR • Online examination, 90 minutes OR • Oral examination, 30 minutes (The corresponding regulation for each semester will be announced in the first lectures.)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	VL + SEM + Prü Electrical Power Generation and Integration of Solar Energy
Components to be offered in the Current Semester	**320104** Lecture/Seminar Electrical Power Generation and Integration of Solar Energy - 4 Hours per Term **320174** Examination Electrical Power Generation and Integration of Solar Energy

Module 13989 MicroGrid Application and Dimensioning

assign to: Modules in Power Generation from Renewables and Energy Storages
Studienrichtung / Vertiefung:Energieerzeugung durch fossile und erneuerbare Energieträger

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13989	Compulsory elective

Modul Title	**MicroGrid Application and Dimensioning** Anwendung und Auslegung von MicroGrids
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Dr.-Ing. Pfeiffer, Klaus
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	After participating in the module, students will have a good command of the basic technologies and components suitable for system operation in MicroGrids. They will acquire a comprehensive understanding of the interaction of the individual components depending on the objectives for the operation of the MicroGrid. Basic engineering design methods are developed among the students. They are familiar with the technical application fields and practical use cases for MicroGrids. The students learn to work independently and can reflect on their learning process. They are able to work together in a team and to jointly work on selected issues of the dimensioning and operation of MicroGrids and to present them to the seminar audience.
Contents	• Introduction to the thematic scope • Technologies suitable for application in MicroGrids • Objectives and operating scenarios for the operation of MicroGrids • Interactions between operating strategy and component selection and dimensioning • Control and monitoring of operation by control systems • Practical examples for the dimensioning of components and corresponding networks • Student presentations (as group or single) about current topics. The presentations are scored. The marks achieved are included in the calculation of the overall grade.
Recommended Prerequisites	• Module *11192 Medium- and Low-Voltage Technology*
Mandatory Prerequisites	none

Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• Script • Literature recommendations are announced during the courses or are part of the scripts.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• a student presentation (as group or single) about current topics, approx. 20 min (20%) • a written examination (80 minutes duration) OR an oral examination (30 minutes duration) (80%) Written and oral exams can be conducted in personal attendance or in an online format.Until the end of the first three weeks of lectures it will be announced, if the examination will be offered in written or oral form.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	VL + SEM + Prü MicroGrid Application and Dimensioning
Components to be offered in the Current Semester	**320131** Lecture Microgrid Application and Dimensioning - 2 Hours per Term **320132** Seminar Microgrid Application and Dimensioning - 2 Hours per Term

Module 13990 Energy Storage Technologies and Grid Integration

assign to: Modules in Power Generation from Renewables and Energy Storages
Studienrichtung / Vertiefung:Energieerzeugung durch fossile und erneuerbare Energieträger

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13990	Compulsory elective

Modul Title	**Energy Storage Technologies and Grid Integration** Energiespeichertechnologien und Netzintegration
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Malekian Boroujeni, Kaveh
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	Students will get an understanding how energy systems work and why energy storages are needed. They get an overview which “use-cases” are capable for storages. Students are able to compare the different types of storage technologies and know their advantages and disadvantages. They will have a basic overview about grid integration of storages and which problems occur with storage using in energy supply. Students will also faced with basic knowledge for economic aspects of storage production and operation costs.
Contents	1. Introduction into energy supply and transport system 2. Storages for compensation of fluctuating energy infeed 3. Mechanical storages (e.g. flywheels, pumped hydro storage) 4. Electrical storages (e.g. batteries) 5. Gas storages, hydrogen and chemical storages 6. Heat storages 7. Grid integration of storages, using in energy supply
Recommended Prerequisites	Fundamental knowledge in engineering and mathematics ist benefical.
Mandatory Prerequisites	No successful participation in **11691 Energy Storage Technology**
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Lecture scripts

Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Written examination, 90 minutes OR • Online examination, 90 minutes OR • Oral examination, 30 minutes (The corresponding regulation for each semester will be announced in the first lecture.)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	VL + SEM + Prü Energy Storage Technologies and Grid Integration
Components to be offered in the Current Semester	**320179** Examination Energy Storage Technologies and Grid Integration

Module 14249 Control of Power-to-X, Storage and X-to-Power Systems

assign to: Modules in Power Generation from Renewables and Energy Storages
Studienrichtung / Vertiefung:Energieerzeugung durch fossile und erneuerbare Energieträger

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	14249	Compulsory elective

Modul Title	**Control of Power-to-X, Storage and X-to-Power Systems** Regelung von Power-to-X, Speicher- und X-to-Power Systemen
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Schiffer, Johannes
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	On the completion of this module, students should be able to: • Develop, use and assess dynamic models of Power-to-X, Storage and X-to-Power Systems • Understand core concepts from optimal control • Design controllers to optimize the plant operation
Contents	The module consists of lectures and exercises in combination with a final study project. In the module, the following topics are addressed for Power-to-X, Storage and X-to-Power Systems: • Dynamic modular modeling • Optimal control methods, especially model predictive control and reinforcement learning • Optimal operation control • Provision of ancillary services
Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 1 hours per week per semester Practical training - 1 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Will be named in the first lecture.
Module Examination	Continuous Assessment (MCA)

Assessment Mode for Module Examination	• Written exam, corresponding to 40% of the final mark. Duration of 80 minutes. Printed and written materials like scripts or books are allowed. For calculations, non-programmable calculators are allowed. Any other type of electronic device is NOT allowed. • Study project, corresponding to 60% of the final mark. Each group (3-4 students) should submit a report (10-15 pages) containing their developments and outcomes of the study project.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	Lecture, Exercise, Project Control of Power-to-X, Storage and X-to-Power Systems
Components to be offered in the Current Semester	**320635** Lecture Control of Power-to-X, Storage and X-to-Power Systems - 2 Hours per Term **320636** Exercise Control of Power-to-X, Storage and X-to-Power Systems - 1 Hours per Term **320637** Study project Control of Power-to-X, Storage and X-to-Power Systems - 1 Hours per Term

Module 11191 EMC in Electrical Power Installations

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11191	Compulsory elective

Modul Title	**EMC in Electrical Power Installations** EMV in elektrischen Anlagen
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Schenk, Mario
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Students will get a deeper understanding of possible interferences in power systems and will be able to design a EMC compatible layout in large scale power installations and systems
Contents	Electromagnetic environment (high frequency impulse fields, lightning impulse overvoltages, switching impulses, low and medium frequency interferences), EMC design criteria (protection against direct lightning stroke, potential grounding, screening, overvoltage protection,filters), EMC system planning (zone concept, interface definition) EMC measuring and testing technique
Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Script
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Written examination, 90 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none

Remarks	• The seminar will include exercises, practical training and homeworks • another registration for this module in moodle • different forms of teaching are announced in moodle
Module Components	• EMC in Electrical Power Installations (lecture/seminar)
Components to be offered in the Current Semester	**320207** Lecture/Seminar EMC in Electrical Power Installations - 4 Hours per Term **320272** Examination EMC in Electrical Power Installations

Module 11192 Medium- and Low-Voltage Technology

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11192	Compulsory elective

Modul Title	**Medium- and Low-Voltage Technology** Betriebsmittel der Mittel- und Niederspannungstechnik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Dr.-Ing. Pfeiffer, Klaus
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The aim of the lecture is to enable students to dimension equipment for medium and low voltage technology and to select it correctly according to the conditions of use. For this purpose, it will be also taught which calculations are required for this.
Contents	• Transformers • Switchgears • Substations • Cables and overhead lines • Switching devices • Basics in symmetrical fault calculation • Calculation of relevant stress parameters to the equipment • Project work (including s.c.-calculation, cable selection and rating of switchgears)
Recommended Prerequisites	Module 11196 *„Introduction in Electrical Power“*
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Script
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	The exam can be in written form or as an oral exam. • For a written examination: 90 minutes duration

	• For an oral exam: 30 min duration Written and oral exams can be conducted in personal attendance or in an online format. Until the end of the first three weeks of lectures it will be announced, if the examination will be offered in written or oral form.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Medium- and Low-Voltage Technology (lecture/seminar)
Components to be offered in the Current Semester	**320101** Lecture/Seminar Medium- and Low-Voltage Technology - 4 Hours per Term **320171** Examination Medium- and Low-Voltage Technology

Module 11196 Introduction in Electrical Power

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11196	Compulsory elective

Modul Title	**Introduction in Electrical Power** Einführung in elektrische Energiesysteme
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Malekian Boroujeni, Kaveh
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The students are able to distinguish and reflect on the relationships between the different fields of the electrical power supply. In addition to the different types of generation, the student can also analyse the various grid types with their different operating elements. Furthermore, the student can also recognise influences on the power quality and evaluate them accordingly.
Contents	• Basics in single phase and three phase systems • Conventional power plants • Generators • Transformers • Operation under normal and fault conditions • Overvoltages
Recommended Prerequisites	Basic understanding in electrical engineering
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Script
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Written examination, 90 minutes

Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	• The lecture will give a short introduction to students with bachelor degrees in electrical engineering (or others), who had no subjects in electrical power engineering in their undergraduate programmes • another registration for this module in moodle • different forms of teaching are announced in moodle
Module Components	• Introduction in Electrical Power (lecture/exercise)
Components to be offered in the Current Semester	**320169** Lecture/Exercise Introduction in Electrical Power - 4 Hours per Term **320173** Examination Introduction in Electrical Power

Module 11199 Auxiliary Power Supply of the Power Plant

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11199	Compulsory elective

Modul Title	**Auxiliary Power Supply of the Power Plant** Elektrische Eigenbedarfsversorgung von Kraftwerken
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Dr.-Ing. Pfeiffer, Klaus
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	Students have in-depth knowledge of auxiliary networks in power plants. They are able to recognise interactions with other subject areas and evaluate cross-disciplinary topics. In this context, the students recognise the interactions between selective protection in auxiliary networks, network topologies, system design and rating of the electrical equipment They are able to independently solve and evaluate application-oriented tasks and problems.
Contents	• Requirements to the auxiliary system • Basic layout, voltage levels and rating depending on power plant type and generator capacity • Redundancy concepts • DC power supply and uninterruptible power supply concepts, emergency generators • M.V.- and L.V.-switchgears in auxiliary networks including transformers, drives, adjustment drives • Selective protection in auxiliary networks • Active and reactive power control of generators, frequency control, static and dynamic stability, generator protection • Transfer concepts
Recommended Prerequisites	• Basic understanding in electrical engineering • Module 11192 *"Medium- and Low-Voltage Technology"*
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester

	Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Script
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	The exam can be in written form or as an oral exam. For a written examination: 90 minutes duration For an oral exam: 30 min duration Written and oral exams can be conducted in personal attendance or in an online format.Until the end of the first three weeks of lectures it will be announced, if the examination will be offered in written or oral form.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Auxiliary Power Supply of the Power Plant (lecture) • Auxiliary Power Supply of the Power Plant (seminar)
Components to be offered in the Current Semester	No assignment

Module 11221 Fundamentals in Power Electronics

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11221	Compulsory elective

Modul Title	**Fundamentals in Power Electronics** Grundlagen der Leistungselektronik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Möhlenkamp, Georg
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Students learn to understand the functional principle of power electronics, their specific components, control structures and the characteristic behaviour. They are able to find suitable concepts and define components and auxiliaries for power converters.
Contents	• Definition of power electronics • Components and their static and transient behaviour • Circuit topologies as grid commutated converter • Self commutated converter • Dc-dc-converter • Resonant and quasi-resonant converter • Single and three phase applications • Characteristic values of components and topologies • Cooling • Passive components and filters • Firing • Driver and protection devices • Pulse-width-modulation • Simulation tools
Recommended Prerequisites	Fundamentals in electrical engineering
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 1 hours per week per semester Practical training - 1 hours per week per semester Self organised studies - 120 hours

Teaching Materials and Literature	will be given in lecture
Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	**Prerequisite:** • Successful completion of the laboratory work **Final Module Examination:** • Written examination, 90 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	The seminar contains a mixture of exercises, laboratory tests and homework.
Module Components	• Fundamenatls in Power Electronics (lecture/seminar/laboratory)
Components to be offered in the Current Semester	**320552** Practical training Fundamentals in Power Electronics - 1 Hours per Term **320551** Lecture/Seminar Fundamentals in Power Electronics - 3 Hours per Term **320576** Examination Fundamentals in Power Electronics

Module 11473 Switching Technologies

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11473	Compulsory elective

Modul Title	**Switching Technologies** Grundlagen der Schalttechnologien
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Heinrich, Christian
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Students know the operating principles of various switching technologies used for power engineering. This covers switching in vacuum, switching in gases and power electronics including the switching devices and its characteristics. Students will also get an overview of application in industrial plants and power grids.
Contents	• Definitions and classification of switching devices • Requirements for switching elements • Vacuum switching chamber and ist characteristics • Power electronic elements and ist static and dynamic behaviour • other switching technologies • Application of vacuum switching tubes in circuit breakers • Circuit breaker application in power grids • Converterdesigns • Converter and ist applications
Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 3 hours per week per semester Exercise - 1 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• Script A list of recommanded literature will be provided during the first course.
Module Examination	Final Module Examination (MAP)

Assessment Mode for Module Examination	• Written examination, 90 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Switching Technologies (lecture/exercis)
Components to be offered in the Current Semester	**320540** Lecture/Exercise Switching Technologies - 4 Hours per Term **320580** Examination Switching Technologies

Module 11493 Calculation of Grids with Renewable Sources

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11493	Compulsory elective

Modul Title	**Calculation of Grids with Renewable Sources** Netzberechnung mit erneuerbaren Quellen
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Dr.-Ing. Pfeiffer, Klaus
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	Students have in-depth knowledge of basics in grid calculation and corresponding computational methods. They are able to recognise interactions with other subject areas and evaluate cross-disciplinary topics. Students acquire the prerequisites to independently solve application-oriented tasks. They are able to identify and apply the correct solution strategy and methodology for practically occurring problems. Basic network calculation methods are confidently mastered at the end of this course.
Contents	• Symmetrical and asymmetrical three-phase system • Transformation methods with focus on symmetrical components • Neutral point treatment • Symmetrical impedances and equivalent circuits • Calculation of asymmetrical fault currents • Nodal voltage method • Mesh-current method • Overview about software solutions in the field of grid calculation • Diverse exercises for manual calculations for given grid layouts
Recommended Prerequisites	Module *"Medium- and Low-Voltage Technology"*
Mandatory Prerequisites	None
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours

Teaching Materials and Literature	• Script • Reference books about power supply (Herold)
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	The exam can be in written form or as an oral exam. • For a written examination: 90 minutes duration • For an oral exam: 30 min duration Written and oral exams can be conducted in personal attendance or in an online format.Until the end of the first three weeks of lectures it will be announced, if the examination will be offered in written or oral form.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	None
Module Components	• Calculation of Grids with Renewable Sources (lecture/seminar)
Components to be offered in the Current Semester	No assignment

Module 11494 Control Engineering 1

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11494	Compulsory elective

Modul Title	**Control Engineering 1** Regelungstechnik 1
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Schiffer, Johannes
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	On completion of this module, students should be able to: • Analyze the behavior of linear dynamical systems in the frequency domain; • Design single-input-single-output controllers in the frequency domain; • Control linear systems with time delays; • Have developed an understanding for the application of control engineering methods to real-world applications based on examples and laboratory exercises.
Contents	Feedforward and feedback control; Fundamentals on signals and systems (repetition); Description of dynamical systems in the time and frequency domains; Frequency response; Control system properties and specifications; Stability; Hurwitz criterion; Nyquist criterion; Bode diagrams; Controller synthesis in the frequency domain; PID control; Cascaded control; Control of systems with time delays.
Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Laboratory training - 1 hours per week per semester Self organised studies - 105 hours
Teaching Materials and Literature	• K. J. Åström and R. M. Murray, "Feedback Systems", Princeton University Press, 2009

- G. F. Franklin, J. D. Powell, A. Emami-Naeini, "Feedback Control of Dynamic Systems", Vol. 3. Reading, MA: Addison-Wesley, 1994
- J. Lunze, "Regelungstechnik 1", Springer-Verlag, 2013
- Unbehauen, Heinz, "Regelungstechnik I – Klassische Verfahren zur Analyse und Synthese linearer kontinuierlicher Systeme", Vieweg Verlag Braunschweig/Wiesbaden

Module Examination

Prerequisite + Final Module Examination (MAP)

Assessment Mode for Module Examination

Prerequisite:
- Submission of at least 65% of the online homework
- Successful participation in all lab sessions including short tests (ungraded)

Final Module Examination:
- Written exam, 90 minutes

Permitted aids are **two** DIN A4 sheets, **handwritten** on both sides. For calculations, non-programmable calculators are allowed. Any other type of electronic device is **not** allowed. For successfully completed online homework, a maximum of 10% bonus points can be earned for the final examination.

Evaluation of Module Examination

Performance Verification – graded

Limited Number of Participants

none

Remarks

none

Module Components

- Control Engineering 1 (lecture)
- Control Engineering 1 (exercise/practical training)
- Control Engineering 1 (exam)

Components to be offered in the Current Semester

320630 Lecture
Control Engineering 1 - 2 Hours per Term
320631 Exercise/Practical training
Control Engineering 1 - 3 Hours per Term
320673 Examination
Control Engineering 1

Module 11496 Research Seminar in Power Electronics

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11496	Compulsory elective

Modul Title	**Research Seminar in Power Electronics** Forschungsseminar Leistungselektronik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Möhlenkamp, Georg
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	On special announcement
Credits	6
Learning Outcome	At the end of the module the student is able to: • analyse advanced topics in power electronics • discuss and evaluate recent developments • present a selected topic • write a research or review report
Contents	Current selected research topics in the field of: • power electronics for high-voltage networks, • power electronics for e-cars, • design of energy efficient, high performance drives • optimization of complex drive systems
Recommended Prerequisites	• Urgently recommended: module 35436 *Power Electronic Applications in High Voltage Grids* • Urgently recommended: module 35437 *Power Electronic Applications in Drive Systems*
Mandatory Prerequisites	Successful participation in module: • 11221 - Fundamentals in Power Electronics
Forms of Teaching and Proportion	Seminar - 4 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Literature is depending from the research topic.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Oral presentation and discussion (50%), ca. 15 min. • Written report (50%), ca. 20 pages

	At least 75% are required to pass the module successfully.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	None
Module Components	• Research Seminar in Power Electronics (seminar)
Components to be offered in the Current Semester	**320560** Seminar Research Seminar in Power Electronics - 4 Hours per Term

Module 11696 Generators and Large Drives

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11696	Compulsory elective

Modul Title	**Generators and Large Drives** Generatoren und große Antriebe
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Möhlenkamp, Georg
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	At the end of the module, students are able to: • understand the working principals and design criteria of large generators and drives, • analyze and evaluate the operation of generators and drives in electrical networks with conventional and renewable power generation plants
Contents	• Basics of synchronous generator operation • Basics of induction generator at grid operation • Basics of doubly fed asynchronous generator operation • Requirements of transmission and distribution grids • Conventional power generation plants and generators • Renewable power plants and their respective generators
Recommended Prerequisites	• Fundamentals in Electrical Machines • Fundamentals in Power Electronics
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 3 hours per week per semester Exercise - 1 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Will be given in class
Module Examination	Final Module Examination (MAP)

Assessment Mode for Module Examination	• Written examination, 90 minutes **OR** • Oral examination, 30 minutes In the first lecture it will be announced, if the examination will be offered in written or oral form.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	None
Module Components	• Generators and Large Drives (lecture) • Generators and Large Drives (exercise)
Components to be offered in the Current Semester	**320550** Lecture/Exercise Generators and Large Drives - 4 Hours per Term **320574** Examination Generators and large drives

Module 11747 Control Engineering 2

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11747	Compulsory elective

Modul Title	**Control Engineering 2** Regelungstechnik 2
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Schiffer, Johannes
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	On completion of this module, students should be able to: • Model dynamical multiple-input-multiple-output (MIMO) systems from diverse domains in state-space form; • Analyze the behavior of linear state-space systems; • Understand the concepts of controllability and observability for linear time-invariant (LTI) systems; • Design static and observer-based dynamic state-feedback controllers for LTI MIMO systems.
Contents	State space modeling of dynamical systems; Dynamic behavior of linear systems; Solution of linear time-invariant systems; Lyapunov stability; Controllability and observability; State feedback; Pole placement; PI state feedback control; Control design via linear matrix inequalities; Duality principle; Luenberger-observer and observer-based control; Separation principle; Optimal control (Linear quadratic regulator, H-infinity control)
Recommended Prerequisites	Knowledge in: • Mathematics • Physics • Control Engineering 1 (or equivalent)
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Laboratory training - 1 hours per week per semester Self organised studies - 105 hours

Teaching Materials and Literature	• K. J. Åström and R. M. Murray, "Feedback Systems", Princeton University Press, 2009 • G. F. Franklin, J. D. Powell, A. Emami-Naeini, "Feedback Control of Dynamic Systems", Vol. 3. Reading, MA: Addison-Wesley, 1994 • H. Khalil, "Nonlinear Systems", Prentice-Hall, New Jersey, 1996 • J. Lunze, "Regelungstechnik 2: Mehrgrößensysteme Digitale Regelung", Springer-Verlag, 2013
Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	Prerequisite: • Submission of at least 65% of the online homework • Successful participation in all lab sessions including short tests (ungraded) Final Module Examination: • Written exam, 90 minutes Permitted aids are **two** DIN A4 sheets, **handwritten** on both sides. For calculations, non-programmable calculators are allowed. Any other type of electronic device is **not** allowed. For successfully completed online homework, a maximum of 10% bonus points can be earned for the final examination.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Control Engineering 2 (lecture) • Control Engineering 2 (exercise/laboratory) • Control Engineering 2 (exam)
Components to be offered in the Current Semester	**320671** Examination Control Engineering 2

Module 11750 Power System Operation

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11750	Compulsory elective

Modul Title	**Power System Operation** Systemführung von Elektroenergienetzen
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Malekian Boroujeni, Kaveh
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	Students will gain a deep understanding of power system stability. A general overview of power systems, including current trends, will be presented. Students will acquire a basic understanding of the influence of new trends on power systems, with a focus on renewable energies and inverter-interfaced storage systems. Additionally, students will become familiar with some well-known stability events from practical experience.
Contents	• Overview of power systems • Current trends in power systems • Overview of power system stability • Frequency stability • Voltage stability • Rotor angle stability • Stability events from practical experience
Recommended Prerequisites	Knowledge: • Module *11493 Calculation of Grids with Renewable Sources* • Module *35409 Power Automation* • Module *35436 Power Electronic Applications in High Voltage Grids* • Module *11696 Generators and Large Drives* • Module *11196 Introduction in Electrical Power*
Mandatory Prerequisites	No successful participation in associated phase-out module *11193 Power System Operation.*
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester

	Self organised studies - 120 hours
Teaching Materials and Literature	Script
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Coursework with the corresponding presentation. Depending on the actual number of participants, the presentation topics will be given as group work or as individual presentations. The defined presentation duration is approx. 20 minutes, followed by a discussion and Q&A session. (20%) • Written examination, 80 minutes OR oral examination, 30 minutes (80%) Within the first three weeks of the semester it will be announced, whether the examination will be offered in written or oral form.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	18
Remarks	• ***Module with limited number of participants – Registration two weeks prior to the commencement of lectures!***
Module Components	• Power System Operation (lecture) • Power System Operation (seminar)
Components to be offered in the Current Semester	**320282** Examination Power System Operation

Module 11857 Energy Systems Modelling

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11857	Compulsory elective

Modul Title	**Energy Systems Modelling** Energiesystemmodellierung
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. Müsgens, Felix
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The course provides knowledge and tools tounderstand thefundamental interactionsin energy systems. Participants will learn: • the basic theory behind LP, MILP, NLP and MCP modelling approaches, • the specifics of energy systems and their conversion into mathematical problems, • to implement and solve these mathematical problems with software packages and • to choose appropriate optimization methods and interpret results.
Contents	The course covers the basic ideas of optimization theory with applications to energy systems. Mathematical models are introduced to allow for quantitative analyses of the competitive behaviour and strategic interactions of relevant market participants. A number of illustrative numerical problems will be applied to discuss the following aspects of energy markets: • Economic fundamentals ofelectricity and natural gas systems • Pricing and investments • Short-term dispatch and long-term equilibrium • Market integration of renewable energy sources • Emissions from electricity production • CO_2 cap vs CO_2 tax • Electricitytransport and distribution • Congestion in electricity networks • Nodal & zonal pricing schemes • Unit commitment decision of power plants • Demand elasticity • Game theory

	• Strategic behaviour • Market power on energy markets
Recommended Prerequisites	Knowledge: • Module *35303 Power System Economics 1* or • Module *35101 Allgemeine Energiewirtschaft 2*
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Will be given in class
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	1. Hometasks (33%) 2. Study Projects (34%) 3. Written examination, 60 min (33%)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	15
Remarks	none
Module Components	• Energy Systems Modelling (lecture) • Energy Systems Modelling (exercise)
Components to be offered in the Current Semester	**320303** Lecture Energy Systems Modelling - 2 Hours per Term **320304** Exercise Energy Systems Modelling - 2 Hours per Term

Module 12233 Experiments in Aerodynamics and Fluid Mechanics

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	12233	Compulsory elective

Modul Title	**Experiments in Aerodynamics and Fluid Mechanics** Experimente in Aerodynamik und Strömungslehre
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Egbers, Christoph
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Participants of the module Experiments in aerodynamics and fluid mechanics will be able to understand the topic from an analytic and a practical point of view. The main scope is the understanding of fundamental Fluid mechanics. At the end of the module the students are able to understand basic aerodynamic and fluid mechanics phenomena as well as measurement techniques which are state of the art.
Contents	The specific topics will be explained theoretically in the lecture while in the exercise experiments will be performed. The experiments will focus on different fundamental flow phenomena and investigate them using different measurement techniques. The main contents of the module will be: • Wind tunnel • Water tunnel • Flow around bodys • Principle of Airfoil • Laminar flow • Turbulence • Pipe flow • Rotating Machinery • Flow Instabilities • Taylor-Couette flow • Convection • Aeroacoustics • Aeolsharp • Karman Vortex street • Car Aerodynamics • Wheel housing

	• Flow Visualization techniques • Pressure measurements • LASER-based measurement techniques • Particle Image Velocimetry • Laser Doppler Anemometry
Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 1 hours per week per semester Exercise - 3 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• Selected literature will be presented at the beginning of the module. • Guidelines for the experiments will be given in first lecture
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Written project reports of 10 experiments (2/3) • Oral defense of one experiment, 10 minutes (1/3)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	This module is based on experimental and fluid mechanical knowledge. The interested students should bring skills on these fields.
Module Components	participation in lecture, exercise
Components to be offered in the Current Semester	**350124** Lecture Experiments in Aerodynamics and fluid mechanics - 1 Hours per Term **350125** Exercise Experiments in Aerodynamics and fluid mechanics - 3 Hours per Term

Module 12642 EEEIC SEd - International Conference on Environment and Electrical Engineering - Student Edition

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	12642	Compulsory elective

Modul Title	**EEEIC SEd - International Conference on Environment and Electrical Engineering - Student Edition** EEEIC SEd - International Conference on Environment and Electrical Engineering - Student Edition
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Schenk, Mario
Language of Teaching / Examination	English
Duration	2 semesters
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The students develop a sustainable, intercultural understanding for Eastern Europe and receive an overview of energy policies and technical development trends in the German-Polish-Czech border region. Through the preparation of conference papers and presentations in English the students learn to present scientific results of their research and through participation in an international conference they gain IEEE recognition. Additional insights into the culture and work environment of the partner countries are conveyed through a post conference tour, which also enables the establishment of permanent contacts between young scientists from the partner universities in Wroclaw, Ostrava and Cottbus.
Contents	Since 2002 parallel seminars are held at the University of Technology Wroclaw, Technical University of Ostrava and the BTU in order to promote a German-Polish-Czech student exchange in the fields of power engineering, economics and politics. The main focus of the module is to raise awareness of the students on the development of sustainable technologies with future potential for production, storage and controlled transmission of electric power in the border regions in cooperation with speakers from partner universities. Historical and social context will be presented as well as research aims and development tendencies, in order to improve the understanding of the above mentioned issues. The students will choose a project topic out of diverse approaches and viewpoints in the field of energy

	production, form the working groups and produce a conference report and a presentation. Enhancement of presentation skills and report writing is one of the secondary objectives of the seminar. In 2009 a division was made into separate events for researchers and students, due to an increased interest in this event of international staff and students at the three partner universities. Since 2011 the EEEIC is organized as a conference for the scientific community and as a student edition with a workshop and a tour for students in order to promote young talents.
Recommended Prerequisites	none
Mandatory Prerequisites	• Bachelor • No successful participation in the associated phase-out module 11396 Internationale Konferenz über Umwelt- und Energietechnik - Student Edition
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• Script • Template for conference report • Template for conference presentation
Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	Prerequisite: • Participation on the student conference • Conference contribution consisting of report (4-5 pages in English language) Final Module Examination • presentation (15 min. in English language)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	25
Remarks	• block courses • dates will be announced by dirk.lehmann@b-tu.de • registration for this module in moodle • different forms of teaching are announced in moodle
Module Components	lecture no: 320258
Components to be offered in the Current Semester	**320258** Lecture/Seminar EEEIC SEd - International Conference on Environment and Electrical Engineering - Student Edition - 4 Hours per Term **320280** Examination EEEIC SEd - International Conference on Environment and Electrical Engineering - Student Edition

Module 13169 Gas Cleaning

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13169	Compulsory elective

Modul Title	**Gas Cleaning** Gasreinigung
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Riebel, Ulrich
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	Student will be able to: • understand working principle of diverse devices for the control of gaseous emissions. • understand relations between apparatus or process design and performance. • select and combine appropriate technologies for the reduction of emissions in specific situations.
Contents	Introduction – applications of gas cleaning in industrial processes and pollution control. Historical development and legislation. Various topics of particle separation and dust control. Characterization of particle size distributions and separation efficiency. Gravitational and inertial particle separators. Filters. Electrostatic precipitators. Wet scrubbers. Droplet separation. Combinations of separators. Separation of acid gases (HCl, HX, SO2/SO3 and others) Reduction of NOx, SNCR and SCR processes. Reduction of VOCs. Special Topics (Mercury, PAHs, Dioxins).
Recommended Prerequisites	Students should have a bachelor´s degree in engineering science or physics
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 3 hours per week per semester Laboratory training - 1 hours per week per semester Self organised studies - 120 hours

Teaching Materials and Literature	• N.A. Fuchs: The Mechanics of Aerosols (Dover 1965) • W. Strauss: Air Pollution Control, (WILEY 1971) • W. Hinds, Aerosol Technology (Wiley 1982,) • F. Löffler: Staubabscheiden (G. Thieme 1988) • JPK Seville: Gas Cleaning in Demanding Applications (Springer 1997) • K. Spurny: Advances in Aerosol Filtration (CRC Press, 1998) • K. Görner, K. Hübner: Gasreinigung und Luftreinhaltung (Springer 2002)
Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	**Prerequisite for Final Module Examination:** • The laboratory report (ca. 10 pages) is a prerequisite for admission to the final module examination. **Final Modul Examination:** • Oral (30 min/participant) **OR** • Written (1.5 hrs) examination Kind of final module examination will be defined when the module starts.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	25
Remarks	none
Module Components	• 230301 Gas CleaningExamination Gas Cleaning
Components to be offered in the Current Semester	**360372** Examination Gas Cleaning

Module 13294 Control Technology for Processes and Networks

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13294	Compulsory elective

Modul Title	**Control Technology for Processes and Networks** Leittechnik für Prozesse und Netze
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Schiffer, Johannes
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The students get some advanced knowledge about applications, tasks and technical equipment of Process Control Systems (PCS) and Network Control Systems (NCS) with the focus on power grids. The students are able to describe concentrated and distributed systems of process and network control technology and to project and configure them for an application. Tasks from the process and automation level up to the operating and visualization level are included. This requires the application of interdisciplinary knowledge. In theoretical and practical exercises, the students are enabled to solve detailed tasks of signal and information processing and visualization. The exercises promote both, independent work in preparation and jointly exchange in technical discussions.
Contents	Terms and definitions for modern control systems and the primary processes (with the focus on power grids). A short view to the history. Structure and parts of modern control systems: Real time units, stations for operation and visualisation, communication buses, analog and digital signal processing and informations, sensors and actors, computeraided design and programming, project management and documentation. Basic and advanced tasks of modern control systems: control, stabilisation, safety, visualisation and operation, reporting and optimization (important for power grids: generation and distribution management). View to the future: Smartgrids
Recommended Prerequisites	none
Mandatory Prerequisites	No successful participation in Modul 35416 Prozessleitsysteme.

Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Actual informations in the lectures. Scripts and working materials are available.
Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	Prerequisite: • short tests during the semester Final Module Examination: • written examination at the end of the semester (90 minutes) Printed and written materials like scripts or books are allowed. For possible calculations a non-programmable calculator is allowed.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	Lectures - 2 hours per week per semester Exercises - 2 hours per week per semester Self organised studies -120 hours
Components to be offered in the Current Semester	**320645** Lecture Control Technology for Processes and Networks - 2 Hours per Term **320646** Exercise Control Technology for Processes and Networks - 2 Hours per Term **320679** Examination Control Technology for Processes and Networks

Module 13717 Decarbonisation of Industrial Processes

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13717	Compulsory elective

Modul Title	**Decarbonisation of Industrial Processes** Dekarbonisierung von Industrieprozessen
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. rer. nat. habil. Riedel, Uwe
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every semester
Credits	6
Learning Outcome	Participants of the module will be able to understand the specific challenges of CO_2-reduction in the industrial sectors. Readiness of current and emerging technologies (technology readiness level) and significance for a successful energy transition for various industrial sectors will be discussed. Focus is on the decarbonization of heat as a crosscutting technology and the steel, chemistry, cement sector – each having specific challenges. At the end of the module the students will be able to name the requirements for achieving climate goals in various industrial sectors. Furthermore, students will be able to assess, evaluate, and select different decarbonization strategies for specific industrial processes. Specific cognitive learning goals are: • Apply analysis tools like pinch analysis, techno-economics, and energy-hub designs • Analyze selected industrial processes in case studies • Derive and evaluate suitable decarbonization options in a group-project • Get insights into options for process changes and decarbonization in the sectors steel, chemistry, and cement as well as process heat • Understand the role of Carbon Capture and Use (CCU) and Carbon Capture and Storage (CCS) for unavoidable CO_2-emissions. Affective learning goals are: • Integration in a team and potential conflicts, • deal with feedback in an open presentation session, • deal with potential frustration in a research project.
Contents	The specific topics will be explained in the lecture while the exercise and the project parts will provide more in-depth deeper qualitative and

	quantitative analyses. The projects will focus on specific industries and their options to reduce their carbon footprint. The lecture part is structured as follows: • Introduction • Techno-Economic Analysis • Pinch Analysis • Renewable Energy Hub Design • Industrial Heat • Steel Industry • Chemical Industry • Cement Industry These lectures are supported by exercises on techno-economic analysis, Pinch Analysis, energy hub design and CCU/CCS. The decarbonization techniques learned will then be applied as part of a study project.
Recommended Prerequisites	Bachelor in Engineering or Natural Sciences
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 1 hours per week per semester Study project - 2 hours per week per semester Self organised studies - 105 hours per week per semester
Teaching Materials and Literature	• Selected literature will be recommended at the beginning of the module. • Handouts for the lecture will be provided. • Options and guidelines for the project work will be given in the first lecture.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	Option A: • A 10-minute electronic presentation of the study project at the beginning of the exam (1/3 weight) and • Oral exam, 20 minutes, questions related to the lecture and the exercise (2/3 weight) Option B: • Multiple-choice test, 20 minutes (30% weight) • Written examination, 60 minutes: Questions related to the lecture, the exercise, and the outcome of study project (70% weight) The lecturer decides and informs at the beginning of the course which option is used as assessment mode.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• VL Decarbonization of Industrial Processes

- Ü Decarbonization of Industrial Processes
- PROJ Decarbonization of Industrial Processes

Components to be offered in the Current Semester

322201 Lecture
Decarbonization of Industrial Processes - 2 Hours per Term
322202 Exercise
Decarbonization of Industrial Processes - 1 Hours per Term

Module 13795 Market Integration of Renewable Energies and Sector Coupling

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13795	Compulsory elective

Modul Title	**Market Integration of Renewable Energies and Sector Coupling** Marktintegration erneuerbarer Energien und Sektorenkopplung
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. rer. nat. Ragwitz, Mario
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The course gives a comprehensive overview of all relevant aspects of market integration of renewable energies including quantitative modelling based on the model PyPSA. Based on a detailed characterisation of the challenges of market integration the different flexibility options available within modern energy systems will be introduced and their impact on the market outcome will be assessed quantitatively. Furthermore, regulatory and policy choices will be addressed. After attending the module "Market Integration of Renewable Energies and Sector Coupling" the student will have a deeper understanding of the challenges and options of the integration of renewable energies into energy markets. Furthermore, the student will be familiar with the definition of sector coupling and the various technologies and organisational options for the integration of energy sectors. Students will understand the impact of the regulatory framework and technology choices on the market integration of renewable energies and will be able to apply methods and tools for analysis of energy markets.
Contents	• Scenarios for the development of future energy systems • Definition and challenges of market integration of renewable energies • Instruments for market-based investment decisions and dispatch of renewable energies • Technology options for the integration of energy sectors • Flexibility options on the supply and demand side and based on based on storage technologies • Value of flexibility at the energy market

	• The role of grid infrastructures for the market integration of renewable energies • Python Programming Fundamentals: Introduction to reading and writing Python code, focusing on important programming concepts necessary for energy modeling. • Introduction to simulation and optimisation techniques in energy system modelling • Methodologies for analyzing and managing datasets • Policies for renewable energy sources in the power sector
Recommended Prerequisites	Participation at • module 35303 - "Power System Economics I" and • module 35401 - "Power System Economics II" is strongly recommended
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 90 hours
Teaching Materials and Literature	• Script (slides) • Reference books • Agora Energiewende. 2018. Energiewende 2030: The Big Picture – Megatrends, Targets, Strategies and a 10-Point Agenda for the Second Phase of Germany's Energy Transition. Impulse. Berlin • IEA (2022), World Energy Outlook 2022, IEA, Paris https://www.iea.org/reports/world-energy-outlook-2022 • IEA (2011), Integration of Renewables, IEA, Paris https://www.iea.org/reports/integration-of-renewables • Winkler (2016)): Market integration of renewables in the electricity sector – impact on electricity markets and renewable support policy as well as interactions with system flexibility, Dissertation, University of Freiburg. • JRC – Joint Research Centre (2020): Towards net-zero emissions in the EU energy system by 2050 – Insights from scenarios in line with the 2030 and 2050 ambitions of the European Green Deal. EUR 29981 EN. Publications Office of the European Union, Luxembourg, doi:10.2760/081488. • Wietschel, M.; Held, A.; Pfluger, B.; Ragwitz, M. (2020): Energy integration across electricity, heating & cooling and the transport sector – Sector coupling. Fraunhofer ISI Working Paper Sustainability and Innova-tion, No. S 08/2020 • Energy sector magazines
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Written examination, 60 minutes OR oral examination, 30 minutes (the lecturer decides and informs at the beginning of the course) 60 % • 2 Seminar works including presentation (duration 15 minutes, presentation ca. 10 slides) 40 %

Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	20
Remarks	none
Module Components	• VL Market Integration of Renewable Energies and Sector Coupling • Proj Market Integration of Renewable Energies and Sector Coupling
Components to be offered in the Current Semester	**322101** Lecture Market Integration of Renewable Energies and Sector Coupling - 2 Hours per Term **322102** Seminar/Exercise Market Integration of Renewable Energies and Sector Coupling - 4 Hours per Term

Module 13926 Hydrogen and Fuel Cells

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13926	Compulsory elective

Modul Title	**Hydrogen and Fuel Cells** Wasserstoff und Brennstoffzellen
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. rer. nat. Röntzsch, Lars
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Students are introduced to the complete chain of hydrogen energy technology, covering hydrogen production, storage, distribution, and utilization. Each chapter of the course explores the physico-chemical principles underlying specific hydrogen technologies, provides a detailed description of the technology (including material selection and production aspects), and illustrates its applications through practical examples. The course also incorporates exercises and a graded laboratory experiment, enhancing hands-on learning and practical application of theoretical knowledge.
Contents	1. Introduction to hydrogen and its properties 2. Hydrogen energy cycle 3. Hydrogen production 4. Hydrogen purification 5. Hydrogen storage 6. Distribution and infrastructure 7. Fuel cells 8. Hydrogen combustion 9. Hydrogen safety
Recommended Prerequisites	Good knowledge and coherent understanding of power engineering, physics, chemistry, and mathematics (Master's level)
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 3 hours per week per semester Exercise - 1 hours per week per semester Self organised studies - 120 hours

Teaching Materials and Literature	The course documents are provided in the learning management system Moodle. Further literature: • Compendium of Hydrogen Energy, Volumes 1-4 (Woodhead, 2015). • Hydrogen - Its Technology and Implications, Volumes 1-5 (CRC Press, 2018). • Fuel Cells and Hydrogen Production (Springer Science, 2019). • Hydrogen Energy - Challenges and Solutions for a Cleaner Future (Springer, 2019). • Hydrogen Production Technologies (Wiley, 2017). • Handbook of Hydrogen Energy (CRC Press, 2014). Hydrogen Safety (CRC Press, 2013).
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Final written exam (80 min; 75 % of final grade) • Graded laboratory experiment (entrance test (~10 min.), self-managed realisation (~80 min.) and report including evaluation of the experiments (at least 10 pages); 25 % of final grade)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	30
Remarks	none
Module Components	Lectures, exercises, laboratory experiment, exam
Components to be offered in the Current Semester	**320455** Lecture/Practical training Hydrogen and Fuel Cells - 4 Hours per Term

Module 13951 Project Laboratory Control and Network Control Technology

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13951	Compulsory elective

Modul Title	**Project Laboratory Control and Network Control Technology** Projektpraktikum Regelungs- und Netzleittechnik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Schiffer, Johannes
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	After completion of this module, students should be able to: • Apply modern methods of control systems and network control technology to emerging research and development challenges in a core engineering domain, such as power system operation, microgrids, grid integration of renewable generation, robotics or multi-agent systems; • Define an overall R&D project design objective including technical specifications; • Develop a work plan suitable to achieve the overall project task and which distributes the workload amongst all team members; • Demonstrate project management skills including time planning, team work, working to deadlines and producing deliverables; • Demonstrate creativity, innovation, independence and technical competence by implementing the project proposal, delivering the design and development work as specified in the project plan; • Demonstrate improved proficiency in written and oral communications; • Understand how to make use of technical literature and other information sources.
Contents	In the project laboratory groups of two to four students are involved in the joint organization and delivery of a R&D engineering project in the areas of control systems and network control technology. The project topics are suggested by the module leader (and possible further project supervisors) based on current research and development activities in the abovementioned areas. Hence students are provided with a unique hands-on experience in the application of modern control systems and

	network control technology methods to meet emerging technological challenges. In contrast to conventional laboratory modules, students will only be provided with the project task and will have to develop independently their own plan of work and distribute the work load amongst the different team members. Therefore each team member is responsible for the success of the whole group. The supervision of the project laboratory mainly consists of consultation and feedback on the project design, organization and implementation through regular meetings at fixed times. Necessary technical devices and reading material as well as data sheets will be provided.
Recommended Prerequisites	Scientific curiosity and interest in application-oriented research. Depending on the specific project topic good knowledge of some of the following topics is helpful: control systems fundamentals, Matlab/ Simulink, C/C++, hardware-oriented programming of microcontrollers, communication systems and network control technology.
Mandatory Prerequisites	No successful participation on module *12893 - Project Laboratory Control and Network Control Technology*
Forms of Teaching and Proportion	Seminar - 2 hours per week per semester Study project - 120 hours Self organised studies - 30 hours
Teaching Materials and Literature	None
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Project report, 15-25 pages (70%) • Oral presentation ~15 min. (20%) • Brief oral question and answer session, 15 min. (10%)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	None
Module Components	Seminar and Project "Project Laboratory Control and Network Control Technology"
Components to be offered in the Current Semester	No assignment

Module 13952 Lab Control Engineering

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13952	Compulsory elective

Modul Title	**Lab Control Engineering** Labor Regelungstechnik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Dr.-Ing. Rau, Uwe
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	The students deepen the basic and advanced knowledge of control engineering by applying it to real laboratory experiments and simulated processes. The students are able to reflect on the relationships between modelling, design and practical implementation and to assess the real results in a well-founded manner. With the help of preparatory tasks and experimental instructions, they can develop their own questions and propose justified adjustments to the standard methods of control engineering. The students are able to work together in a group and solve tasks together. On the other hand, independence in the development and application of subject-specific knowledge is encouraged.
Contents	Laboratory experiments with tasks from mechanical engineering, electrical engineering and process engineering: Analysis and controller design in the time and frequency domain, state models, digital control, use of the Matlab/Simulink software package.
Recommended Prerequisites	Ready-to-use knowlegde of the Module 11494 Control Engineering 1 (or similar courses).
Mandatory Prerequisites	No successfull completion of module *35463 - Labor Regelungstechnik*
Forms of Teaching and Proportion	Laboratory training - 4 hours per week per semester Self organised studies - 120 hours per week per semester
Teaching Materials and Literature	Lecture and exercise scripts, instructions of the experiments
Module Examination	Continuous Assessment (MCA)

Assessment Mode for Module Examination	There will be 5-7 experiments (the number will be announced at the beginning of the course). Each laboratory experiment includes: • the preparation (5-10 sheets of paper in the self-study time), • a written test (15 min in attendance time), • the execution (approx. 165 min in attendance time) and • the evaluation (10-15 sheets of paper in the self-study time). Points are awarded for the individual performances. They are distributed as follows: • Preparatory tasks 30%, • Written test 10%, • Execution and protocol 60%. The module grade is calculated on the basis of the total points achieved in the semester. The module is passed (grade 4.0) if 50% of the total points have been achieved.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	None
Module Components	320619 "Laborpraktikum Regelungstechnik".
Components to be offered in the Current Semester	No assignment

Module 13964 Geothermal Energy

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13964	Compulsory elective

Modul Title	**Geothermal Energy** Geothermische Energie
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. rer. nat. Ragwitz, Mario
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	The module provides an overview of geothermal technologies and their application for the generation of electricity, heating & cooling and for underground thermal energy storage. The students understand the geothermal heat source, properties of the subsurface and thermal transfer mechanisms. They apply knowledge to the basic design of local heat distribution systems, the integration of low temperature geothermal heat sources and ground-source heat pumps in the energy supply systems and the use of geothermal storage options for the balancing of seasonal heating&cooling demands with asynchronous supply and demand cycles as well as the basic economic considerations of geothermal energy generation and heat network integration.
Contents	• Basic geological principles • Overview of different geothermal systems • Geothermal fluids – thermal and chemical properties • Heat transfer in the subsurface • Reservoir characterization • Design of a geothermal system • Geothermal electricity: historical development, types of power plants • Geothermal heat usage: residential heating, industrial applications • Environmental issues of geothermal energy • Geothermal heat networks • Integration of ground-source heat pumps in flexible heat supply systems • Economics of geothermal energy and heat networks / disttrict heating • Support schemes for geothermal energy and heat networks / disttrict heating

Recommended Prerequisites	Participation at module on “Fluid Dynamics” recommended
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• Script (slides) • Reference books • R. di Pippo: Geothermal Power Plants Principles, Applications, Case Studies and Environmental Impact 4th Edition, Elsevier, 2015 • George L. Danko: Model Elements and Network Solutions of Heat, Mass and Momentum Transport Processes, Springer-Verlag GmbH. 2016.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Written examination (duration 60 minutes) 60 % • 2 Seminar works (creating presentation slides) including presentation (duration 15 minutes, presentation ca. 10 slides) 40 %
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	20
Remarks	none
Module Components	• VL/Ü Geothermal Energy
Components to be offered in the Current Semester	No assignment

Module 13987 Electrical Power Generation and Integration of Wind Energy

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13987	Compulsory elective

Modul Title	**Electrical Power Generation and Integration of Wind Energy** Elektrische Energieerzeugung und Integration von Windenergie
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Malekian Boroujeni, Kaveh
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Students will get a deep understand of wind energy technologies, including the basics of fundamental principles of wind turbines and their components. Principles of operation of wind turbines regarding important parameters will be introduced. Students will get a basic overview in grid integration and economics of wind turbines and will faced with advantages and disadvantages of fluctuating power infeed. A general overview about planning, operation and maintenance of wind turbines will be shown.
Contents	1. General overview about wind energy 2. Physics of wind energy, drag and lift etc. 3. Construction of wind turbines, components 4. Operation of wind turbines: wind speed, roughness, profiles 5. Power generation concepts of wind turbines 6. Grid integration 7. Planning, operation, maintenance, economics
Recommended Prerequisites	Fundamental knowledge in engineering and mathematics is beneficial.
Mandatory Prerequisites	No successful participation in **11689 Power Generation from Wind Energy**
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours

Teaching Materials and Literature	Students will be provided with slides and materials presented in the lessons. Further recommendations for literature will be announced in the first lectures.
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Written examination, 90 minutes OR • Online examination, 90 minutes OR • Oral examination, 30 minutes (The corresponding regulation for each semester will be announced in the first lecture.)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	VL + Prü Electrical Power Generation and Integration of Wind Energy
Components to be offered in the Current Semester	**320103** Lecture/Seminar Electrical Power Generation and Integration of Wind Energy - 4 Hours per Term **320170** Examination Electrical Power Generation and Integration of Wind Energy

Module 13988 Electrical Power Generation and Integration of Solar Energy

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13988	Compulsory elective

Modul Title	**Electrical Power Generation and Integration of Solar Energy** Elektrische Energieerzeugung und Integration von Solarenergie
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Malekian Boroujeni, Kaveh
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Students will get an introduction into photovoltaics, including the basics of fundamental principles of fabrication and operation of solar cells. Furthermore current PV technology trends and material research towards new concepts will be discussed. Presentation of basic principles of power generation and operation of solar energy. Students will get a basic understanding in grid integration of solar energy and economics of solar energy concepts.
Contents	1. Solar insolation: Energy sources of photovoltaics 2. Photovoltaic technologies (Si-wafer based vs. thin-film PV) and solar cell materials 3. New technology trends and future concepts (e.g. floating PV) 4. Solar power generation and grid integration 5. Basic economics, installation and operation
Recommended Prerequisites	Fundamental knowledge in engineering and mathematics is beneficial.
Mandatory Prerequisites	No successful participation in **11690 Power Generation from Solar Energy.**
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Students will be provided with slides and materials presented in the lessons. Further recommendations for literature will be announced in the first lecture.

Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Written examination, 90 minutes OR • Online examination, 90 minutes OR • Oral examination, 30 minutes (The corresponding regulation for each semester will be announced in the first lectures.)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	VL + SEM + Prü Electrical Power Generation and Integration of Solar Energy
Components to be offered in the Current Semester	**320104** Lecture/Seminar Electrical Power Generation and Integration of Solar Energy - 4 Hours per Term **320174** Examination Electrical Power Generation and Integration of Solar Energy

Module 13989 MicroGrid Application and Dimensioning

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13989	Compulsory elective

Modul Title	**MicroGrid Application and Dimensioning** Anwendung und Auslegung von MicroGrids
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Dr.-Ing. Pfeiffer, Klaus
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	After participating in the module, students will have a good command of the basic technologies and components suitable for system operation in MicroGrids. They will acquire a comprehensive understanding of the interaction of the individual components depending on the objectives for the operation of the MicroGrid. Basic engineering design methods are developed among the students. They are familiar with the technical application fields and practical use cases for MicroGrids. The students learn to work independently and can reflect on their learning process. They are able to work together in a team and to jointly work on selected issues of the dimensioning and operation of MicroGrids and to present them to the seminar audience.
Contents	• Introduction to the thematic scope • Technologies suitable for application in MicroGrids • Objectives and operating scenarios for the operation of MicroGrids • Interactions between operating strategy and component selection and dimensioning • Control and monitoring of operation by control systems • Practical examples for the dimensioning of components and corresponding networks • Student presentations (as group or single) about current topics. The presentations are scored. The marks achieved are included in the calculation of the overall grade.
Recommended Prerequisites	• Module *11192 Medium- and Low-Voltage Technology*
Mandatory Prerequisites	none

Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• Script • Literature recommendations are announced during the courses or are part of the scripts.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• a student presentation (as group or single) about current topics, approx. 20 min (20%) • a written examination (80 minutes duration) OR an oral examination (30 minutes duration) (80%) Written and oral exams can be conducted in personal attendance or in an online format.Until the end of the first three weeks of lectures it will be announced, if the examination will be offered in written or oral form.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	VL + SEM + Prü MicroGrid Application and Dimensioning
Components to be offered in the Current Semester	**320131** Lecture Microgrid Application and Dimensioning - 2 Hours per Term **320132** Seminar Microgrid Application and Dimensioning - 2 Hours per Term

Module 13990 Energy Storage Technologies and Grid Integration

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	13990	Compulsory elective

Modul Title	**Energy Storage Technologies and Grid Integration** Energiespeichertechnologien und Netzintegration
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Malekian Boroujeni, Kaveh
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	Students will get an understanding how energy systems work and why energy storages are needed. They get an overview which “use-cases” are capable for storages. Students are able to compare the different types of storage technologies and know their advantages and disadvantages. They will have a basic overview about grid integration of storages and which problems occur with storage using in energy supply. Students will also faced with basic knowledge for economic aspects of storage production and operation costs.
Contents	1. Introduction into energy supply and transport system 2. Storages for compensation of fluctuating energy infeed 3. Mechanical storages (e.g. flywheels, pumped hydro storage) 4. Electrical storages (e.g. batteries) 5. Gas storages, hydrogen and chemical storages 6. Heat storages 7. Grid integration of storages, using in energy supply
Recommended Prerequisites	Fundamental knowledge in engineering and mathematics ist benefical.
Mandatory Prerequisites	No successful participation in **11691 Energy Storage Technology**
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Lecture scripts
Module Examination	Final Module Examination (MAP)

Assessment Mode for Module Examination	• Written examination, 90 minutes OR • Online examination, 90 minutes OR • Oral examination, 30 minutes (The corresponding regulation for each semester will be announced in the first lecture.)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	VL + SEM + Prü Energy Storage Technologies and Grid Integration
Components to be offered in the Current Semester	**320179** Examination Energy Storage Technologies and Grid Integration

Module 14049 Electrified Aero Engines

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	14049	Compulsory elective

Modul Title	**Electrified Aero Engines** Elektrifizierte Luftfahrtantriebe
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. rer. nat. Enghardt, Lars
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	Students will get a deeper inside into the technology background and aviation requirements of disruptive means for novel propulsion systems to minimize the climate impact of civil aviation. The lecture will tackle air transport vehicles up to the size of a regional aircraft.
Contents	Air transport of the future will have to be more climate friendly. The lecture will give an introduction into the novel field of more or purely electrified aero engines for civil aircraft. The course will provide an holistic overview of different topics in this regard: • Motivation - why do we need novel propulsion systems, what technology solutions are focussed • Component technologies • Architecture of Electrified Aero Engines • Aircraft Integration of Electrified Aero Engines • Aeronautical Requirements • Environmental Impact • Control of Electrified Aero Engines • Test Facilities to Validate and Certificate Novel Aero Engines
Recommended Prerequisites	• Modul 31302 Grundlagen der Konstruktion und Leistungsrechnung
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• Script based on lecture slides

Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• written examination, 90 min., OR electronic-examination, 60 min., OR oral examination, 30 min. *At the beginning of the courses it will be announced the type of examination.*
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	VL, Ü Electrified Aero Engines
Components to be offered in the Current Semester	**352201** Lecture Electrified Aero Engines - 2 Hours per Term **352202** Exercise Electrified Aero Engines - 2 Hours per Term **352271** Examination Electrified Aero Engines

Module 14145 Electrochemical and Chemical Energy Storage and Conversion

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	14145	Compulsory elective

Modul Title	**Electrochemical and Chemical Energy Storage and Conversion** Elektrochemische und chemische Energiespeicherung und -wandlung
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Mauß, Fabian
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	The lecture deals with electrochemical and chemical processes which are important for renewable energy storage and conversion. The lecture incorporates recent research from the Energy Innovation Center of BTU Cottbus-Senftenberg. Students acquire in-depth knowledge of thermodynamic processes, the reaction mechanisms of electro-catalysis, turbulent combustion of fuels and measurement devices to characterize surface and gas phase reactions. They are familiar with the simulation of the teached processes. Students gain in-depth knowledge of the subject area and are able to make scientifically sound judgments.
Contents	Introduction to electro-chemical energy storage and conversion • Power-to-X-to-Power energy and substance cycles • Energy balances and efficiencies • environmental impact … Electrochemistry • Fundamentals • Electrode reaction and Butler-Volmer equation • Impedance spectroscopy • Electrolysis • Lithium-Ion-Battery • Simulation Synthesis & Conversion • Heterogeneous catalysis • Reactor types

	• Power-to-X-to-Power processes • Industrial applications • Surface spectroscopy • Modelling & Simulation Kinetics & Spectroscopy • Transition State Theory (TST), Thermodynamic Formulation of TST • Unimolecular Rate Theory Beyond Lindemann Mechanism • Introduction to Spectroscopy and Laser Diagnostics for Gases (diatomic/polyatomic Spectra, quantitative emission and absorption, LIF and its applications).
Recommended Prerequisites	• Thermodynamics • Heat and mass transfer • Chemistry
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Teaching materials: • Power point presentations
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Written examination, 90 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	None
Module Components	Lecture Seminar
Components to be offered in the Current Semester	**320779** Examination Electrochemical and Chemical Energy Storage and Conversion

Module 14249 Control of Power-to-X, Storage and X-to-Power Systems

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	14249	Compulsory elective

Modul Title	**Control of Power-to-X, Storage and X-to-Power Systems** Regelung von Power-to-X, Speicher- und X-to-Power Systemen
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Schiffer, Johannes
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	On the completion of this module, students should be able to: • Develop, use and assess dynamic models of Power-to-X, Storage and X-to-Power Systems • Understand core concepts from optimal control • Design controllers to optimize the plant operation
Contents	The module consists of lectures and exercises in combination with a final study project. In the module, the following topics are addressed for Power-to-X, Storage and X-to-Power Systems: • Dynamic modular modeling • Optimal control methods, especially model predictive control and reinforcement learning • Optimal operation control • Provision of ancillary services
Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 1 hours per week per semester Practical training - 1 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Will be named in the first lecture.
Module Examination	Continuous Assessment (MCA)

Assessment Mode for Module Examination	• Written exam, corresponding to 40% of the final mark. Duration of 80 minutes. Printed and written materials like scripts or books are allowed. For calculations, non-programmable calculators are allowed. Any other type of electronic device is NOT allowed. • Study project, corresponding to 60% of the final mark. Each group (3-4 students) should submit a report (10-15 pages) containing their developments and outcomes of the study project.
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	Lecture, Exercise, Project Control of Power-to-X, Storage and X-to-Power Systems
Components to be offered in the Current Semester	**320635** Lecture Control of Power-to-X, Storage and X-to-Power Systems - 2 Hours per Term **320636** Exercise Control of Power-to-X, Storage and X-to-Power Systems - 1 Hours per Term **320637** Study project Control of Power-to-X, Storage and X-to-Power Systems - 1 Hours per Term

Module 14357 Low Carbon Electricity and Mobility Concepts

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	14357	Compulsory elective

Modul Title	**Low Carbon Electricity and Mobility Concepts** Emissionsarme Elektrizitäts- und Mobilitätskonzepte
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Schwarz, Harald
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	The students are able to distinguish and reflect on the relationships between the different fields of the electrical power generation and carbon dioxide emissions. Based on the fundamental rules of power grid operation, the student can also analyse the various types of smart grids and storage technologies. Furthermore, the student can also recognise influences of different power train designs within car technology to the carbon dioxide emissions from the mobility sector.
Contents	On the first day of the summer school, an overview of renewable and conventional power generation, including carbon capture and storage will be given to the audience. On the second day, the basics of electrical energy transmission and distribution as well as grid operation management will be explained. Later on, the BTU power system simulator will be visited as an open lab. There will also be an opportunity to visit the high-voltage hall. After the basics of electrical energy storage on third day of the summer school, the design of a storage power plant park in a scenario with at least 80% renewable energy in electricity generation will be presented. Before visiting the BTU Micro Grid on the fourth day, there will be an introduction to micro grid application and dimensioning as well as into integrated and renewable energy systems and power-to-X sector coupling. The last day of the summer school will focus on the technology of battery electric vehicles as well as fuel cell electric vehicles and vehicles with internal combustion engines, hybridized and with alternative fuels, e.g. hydrogen, e-fuel, bio-fuels.
Recommended Prerequisites	The module is offered as a one-week summer school at the end of the summer semester. Participants who wish to register for the module examination should have a basic knowledge of electrical power

	engineering. For participants for whom a certificate of attendance is sufficient, a basic technical interest in energy technology issues is sufficient.
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Self organised studies - 150 hours
Teaching Materials and Literature	none
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• written examination, 90 min
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	The module is offered as a one-week summer school at the end of the summer semester.
Module Components	Lecture Low Carbon Electricity and Mobility Concepts
Components to be offered in the Current Semester	No assignment

Module 14414 Data Analytics and Process Modelling

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	14414	Compulsory elective

Modul Title	**Data Analytics and Process Modelling** Datenanalyse und Prozessmodellierung
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. rer. nat. Röntzsch, Lars
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The students learn to develop, evaluate and validate models, design experiments and analyse data. The focus is placed on practical applications, particularly in process and energy technology. Students are also familiarised with soft sensors and digital twins.
Contents	1. Process Modelling and System Identification 2. Statistics and Data Visualisation 3. Theoretical Foundation for Statistical Analysis 4. Regression Analysis 5. Design of Experiments 6. Soft Sensors and Digital Twins
Recommended Prerequisites	Knowledge of advanced mathematics as well as physics or a basic engineering subject (e.g. electrical engineering, mechanics or thermodynamics) at the university bachelor's level
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	The course materials will be provided through Moodle. Literature: • Shardt, Yuri: Statistics for Chemical and Process Engineers. A Modern Approach. 2nd edition (2022). DOI: 10.1007/978-3-030-83190-5.

	• Shardt, Yuri (2023): Using MATLAB to Solve Statistical Problems. DOI: 10.1007/978-3-031-40299-9. • Shardt, Yuri (2024): Using Excel to Solve Statistical Problems. DOI: 10.1007/978-3-031-65449-7.
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Written exam (120 min)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	The students should bring a laptop for the exercises.
Module Components	• Lecture/exercise Data Analytics and Process Modelling • Exam Data Analytics and Process Modelling
Components to be offered in the Current Semester	**320410** Lecture/Exercise Data Analytics and Process Modelling - 4 Hours per Term **320471** Examination Data Analytics and Process Modelling

Module 14514 Lecture Series Hybrid-Electric Propulsion

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	14514	Compulsory elective

Modul Title	**Lecture Series Hybrid-Electric Propulsion** Ringvorlesung Hybrid-Elektrische Antriebe
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. rer. nat. Enghardt, Lars
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	The module will give an overview into selected topics referring to hybrid-electric propulsion systems from experts in the field - including current research from DLR, CHESCO and BTU, plus invited guests. Each lecture will cover a specific topic chosen by the corresponding lecturer and will give deep insights into current problems and solutions concerning hybrid-electric propulsion systems and their components. Students will thus require expert knowledge on selected, very specific topics from current research areas with suggestions on how to obtain additional (background) information as well as contacts to representatives from academia and industry.
Contents	The lectures are given by experienced researchers from different research institutions. A full list of lectures will be presented at the beginning of the summer semester.
Recommended Prerequisites	none
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Study project - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	The lecture slides will be made available after each lecture if the lecturer agrees and the intellectual property rights situation permits.
Module Examination	Continuous Assessment (MCA)

Assessment Mode for Module Examination	• Students will write a 15 page report on one topic of their choice (70 %) to be chosen from a provided preselection list and • a corresponding presentation of approximately 30 minutes at the end of the semester (30 %).
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	VL, PROJ Lecture Series Hybrid-Electric Propulsion
Components to be offered in the Current Semester	No assignment

Module 14723 Management Tools

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	14723	Compulsory elective

Modul Title	**Management Tools** Management-Werkzeuge
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Fien, Harald
Language of Teaching / Examination	English
Duration	2 semesters
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	In this lecture, students will gain a solid understanding of essential management tools that are commonly applied in real-world business scenarios. By exploring typical management situations—such as developing a corporate strategy, solving complex problems, making high-stakes decisions, and leading organizational change—students will learn how to select and apply appropriate tools to navigate these challenges effectively. Special emphasis is placed on identifying the soft skills required to manage such situations, including planning ability, analytical skills, implementation skills, communication skills and passion. Throughout the lecture, students will also explore how artificial intelligence (AI) can support and enhance the use of traditional management tools. From generative AI to agentic AI, the lecture demonstrates how AI-based solutions can provide valuable insights and improve managerial effectiveness. By the end of the lecture, students will be equipped not only with practical tools and frameworks but also with an understanding of the human and technological dimensions of modern management.
Contents	• Typical management situations • Required management skills • Proven management tools • Leveraging AI in the use of management tools
Recommended Prerequisites	• fundamentals in engineering and preferably power engineering
Mandatory Prerequisites	No successful enrolment for 35443 International Management.
Forms of Teaching and Proportion	Lecture - 1 hours per week per semester

	Self organised studies - 150 hours
Teaching Materials and Literature	• Literature requirements are made during the lecture.
Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	Prerequisites: • Passing learning tests that follow each lecture chapter. Final Module Examination: • eTest, 90 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	50
Remarks	• 1 SWS lectures in the winter and 1 SWS lectures in the summer semester • At the end of the lecture period in the winter and summer semesters there is one attendance day each (the exact dates will be announced during the lecture). • As the lecture has a limited number of participants, self-registration is possible during the usual periods in accordance with the general examination and study regulations until the participant limit is reached. • Participants have to register in Moodle, too.
Module Components	• Lecture Management Tools • Examination Management Tools
Components to be offered in the Current Semester	**320260** Lecture International Management - 1 Hours per Term **320286** Examination International Management

Module 14725 Industrial Heating Systems and their Defossilization

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	14725	Compulsory elective

Modul Title	**Industrial Heating Systems and their Defossilization** Industrielle Wärmeversorgungssysteme und ihre Defossilisierung
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. Stathopoulos, Panagiotis
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	**Cognitive Learning Goals (Knowledge & Understanding)** • Understand the role of industrial heating in different industries and their specific heat demands. (level 1) • Describe various industrial heat distribution systems (steam, thermal oil, hot water, gases) and their efficiency considerations.(level 2) • Explain different fossil heat sources and their applications in industrial heating. (level 1) • Explain the thermodynamic principles of industrial heating (compression, expansion, heat transfer, heat exchangers). (level 3) • Analyze different compressor types used in industrial heat pumps and their performance characteristics. (level 3) • Model thermodynamic cycles for industrial heat pumps and assess efficiency based on working fluids.(level 4) • Compare and contrast heat pumps designed for large temperature glides and steam generation. (level 3) • Explain the working principles and integration strategies of solar thermal and alternative heating technologies. (level 3) • Apply pinch analysis to optimize heat recovery and integrate heat pumps into industrial processes. (level 2) • Evaluate economic and environmental impacts of different industrial heating systems. (level2) **Affective Learning Goals (Attitudes & Values)** • Appreciate the importance of energy efficiency and decarbonization in industrial heating. (level1) • Develop a critical perspective on fossil-based heating systems and their long-term viability.(level 2)

- Recognize the role of regulations (especially EU policies) in shaping industrial heating technologies.(level1)
- Show commitment to sustainable energy solutions by considering alternative heating methods.(levle2)
- Engage in discussions on the trade-offs between economic feasibility and environmental impact. (level3)

Valuing Interdisciplinary Collaboration (Level 4):
- Appreciate the need for collaboration between engineers, policymakers, and business leaders to drive industrial heat pump adoption.

Confidence in Practical Application (Level 5):
- Gain self-efficacy in applying thermodynamic principles and system integration knowledge to real-world heat pump installations.

Psychomotor Learning Goals (Practical & Technical Skills)
- Perform basic thermodynamic calculations related to industrial heat pumps and heating systems.
- Use computational tools to model and evaluate heat pump performance.
- Conduct pinch analysis on industrial processes to identify heat recovery opportunities.
- Design and size a solar thermal system for industrial applications.
- Develop and present an optimized industrial heating system proposal.

Operating Industrial Heat Pump Systems (Level 1):
- Start up, monitor, and shut down an industrial heat pump safely.

Conducting Performance Measurements (Level 4):
- Measure key parameters (temperature, pressure, COP, etc.) and analyze system performance.

Interpreting Technical Diagrams (Level 6):
- Read and understand P&ID (Piping and Instrumentation Diagrams) and system schematics of industrial heat pumps.

Applying Safety Procedures (Level 4):
- Follow proper safety protocols when handling high-temperature heat pumps.

Conducting Efficiency Optimization Tests (Level 4):
- Perform practical tests to improve system efficiency, such as adjusting heat source/sink temperatures or optimizing cycle parameters.

Contents

Chapter 1: Introduction to Industrial Heating Systems
- Overview of Industrial Heating Systems, Environmental & Economic Impacts, and Regulatory Overview
- Industrial Sectors and Their Heat Demand
- Industrial Heat Distribution Systems & Fossil Heat Sources

Chapter 2: Thermodynamic Fundamentals
- Basics of Thermodynamics for Industrial Heating (Compression, Expansion, Cycles)
- Basics of Heat Transfer and Heat Exchangers

	• Compressors in Heat Pump Systems **Chapter 3: Industrial Heat Pump Technologies & Alternative Heating** • Industrial Heat Pumps – Thermodynamic Modeling (Part 1: Vapor Compression, COP, Exergy Analysis) • Industrial Heat Pumps – Thermodynamic Modeling (Part 2: Working Fluids & Environmental Impact) • Industrial Heat Pumps – Thermodynamic Modeling (Part 3: Advanced Cycles & System Integration) • Heat Pumps for Large Temperature Glides • Heat Pumps for Steam Generation • Solar Thermal Systems in Industry • Alternative Heating Technologies (Infrared, Inductive, Resistance, Hybrid Systems) **Chapter 4: Process Integration & Economic Evaluation** • Process Integration Fundamentals & Pinch Analysis • Pinch Analysis for Heat Pump Integration • Economic and Environmental Evaluation of Heating Systems • Final Project and Wrap-Up **Chapter 5: Practical Application & Industry Collaboration** • Interdisciplinary Collaboration in Industrial Heating • Industrial Heat Pump Operation & Safety Lab • Performance Measurement & Efficiency Optimization Lab
Recommended Prerequisites	• Knowledge of thermodynamics, fluid mechanics and heat transfer
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Study project - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Will be announced on the Moodle learning platform or during the courses.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Project work with 8-10 pages documentation (70%) and • 3 presentations over ~10 min. in the course of the semester each counting 10%
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	25
Remarks	The module is divided in two parts: The first will take the first 10 weeks of the semester and will focus on knowledge transfer to make sure that the students have all information and data they need to carry out the project. The last part of the semester is dedicated on a project that the students will carry out as their exam. The project will focus on the application of high temperature heat pumps in real world cases, drawn fro the research projects of the chair. The students will be divided in

groups of five. The whole topic will be structures in puzzle groups. The final exam will be organizeas a closure of the puzzle groups t answer the overarching research question.

Module Components

- Lecture Industrial Heating Systems and their Defossilization
- Project Industrial Heating Systems and their Defossilization

Components to be offered in the Current Semester

322302 Study project
Industrial Heating Systems and their Defossilization - 2 Hours per Term
322301 Lecture/Seminar
Industrial Heating Systems and their Defossilization - 2 Hours per Term

Module 35410 High Voltage Measuring and Testing Technique

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	35410	Compulsory elective

Modul Title	**High Voltage Measuring and Testing Technique** Hochspannungsmess- und Prüftechnik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Schenk, Mario
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	Students will get a detailed knowledge in measuring and testing circuits and equipment with special respect to high voltage applications and will practise their knowledge in several high voltage lab experiments.
Contents	AC, DC and impulse generators with Marx-generator or transformers, oscillating impulse generation, EMP- and cable generators, high current sources, resistive or capacitve dividers, response time, band width, earth capacitance, measuring cables, digital and analog oszilloscopes, rogowski-coils, hall-sensors, shunts, optical voltage and current sensors, dielectric measurements, partial discharge detection
Recommended Prerequisites	None
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Seminar - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Skript
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Written examination, 90 minutes **OR** • Oral examination, 30 minutes In the first lecture it will be announced, if the examination will be offered in written or oral form.

Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• High Voltage Measuring and Testing Technique (lecture/seminar)
Components to be offered in the Current Semester	**320287** Examination High Voltage Measuring and Testing Technique

Module 35436 Power Electronic Applications in High Voltage Grids

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	35436	Compulsory elective

Modul Title	**Power Electronic Applications in High Voltage Grids** Leistungselektronik in Hochspannungsanlagen
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Möhlenkamp, Georg
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	Students get a deeper view into the specific items of power electronics in grid applications. They know typical components, applications and control strategies for designing and use of devices in higher voltage and power levels.
Contents	• High voltage and high current power electronics components • Cooling principles • Serial and parallel connection of components • Multiphase and multilevel converter topologies • Control structures for grid connection and parallel operation • Applications like HVDC and FACTS
Recommended Prerequisites	• Urgently recommended: module 11221 *Fundamentals in Power Electronics* • Control Engineering
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Will be given in lecture
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Oral examination, 30 minutes

Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Power Electronic Applicatins in High Voltage Grid (lecture) • Power Electronic Applications in High Voltage Grid (exercise)
Components to be offered in the Current Semester	**320575** Examination Power Electronic Applications in High Voltage Grid

Module 35437 Power Electronic Applications in Drive Systems

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	35437	Compulsory elective

Modul Title	**Power Electronic Applications in Drive Systems** Leistungselektronik in Antriebssystemen
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Möhlenkamp, Georg
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	Students learn the specific items of power electronics in drive applications. They know the typical topologies, power circuit and control structures and can rate and design a drive converter.
Contents	• Voltage source inverter systems • Converter and control design for dc drives • Reversing operation dc drives • Three-phase asynchronous and synchronous drives • Direct torque control and vector control • Pulse-width-modulation for drive converter • Drives with recuperation • Dimensioning of converter systems
Recommended Prerequisites	• Urgently recommended: module 11221 *Fundamentals in Power Electronics* • Electrical Machines • Control Engineering
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 1 hours per week per semester Laboratory training - 1 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	Will be given in lecture
Module Examination	Final Module Examination (MAP)

Assessment Mode for Module Examination	• Written examination, 90 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Power Electronic Applications in Drive Systems (lecture) • Power Electronic Applications in Drive Systems (exercise) • Power Electronic Applications in Drive Systems (laboratory)
Components to be offered in the Current Semester	**320577** Examination Power Electronic Applications in Drive Systems

Module 35449 Power Plant Technology 1

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	35449	Compulsory elective

Modul Title	**Power Plant Technology 1** Kraftwerkstechnik 1
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. rer. nat. Röntzsch, Lars
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The objective of this course is to make students learn about various power generation processes and technologies. The course will cover the fundamental thermodynamic power cycles viz. Rankine cycle, Brayton cycle and various ways to improve cycle efficiency and associated practical challenges. With this theoretical foundation of power generation technologies, further instructions will be focused on fuels and combustion systems and the environmental impacts originating from power plant emissions and their mitigation strategies. Students will be able to develop theoretical and practical understanding of the power generation by various energy sources. They will be able to comprehend physical processes, operating principle and design of conventional and renewable power plants.
Contents	**Introduction to power generation:** Introduction, primary energy sources, energy conversion, steam power plant, nuclear power plants, hydropower plants, solar power plants, thermal energy, wind power plants, waste-to-power generation, geothermal power plants, biomass-based power plants, hydrogen and fuel cells, world energy statistics **Steam power plants:** Introduction, phases of a pure substance, construction of p-v, T-s, and h-s diagrams, water-steam tables, Carnot cycle, Rankine cycle, reheating and regeneration, feedwater heaters, supercritical pressure cycle, deaerator, binary vapour cycle, combined cycle plants, economics of power generation **Gas power plants:** Introduction, classification of gas turbine plants, gas power cycle, analysis of the Joule-Brayton cycle, air standard cycle assumptions, regeneration, reheating and intercooling, combined gas and steam power cycle

	Fuels and combustion: Introduction, classification of fuels, solid fuels, analysis of coal, gaseous fuels, liquid fuels, combustion of fuels, composition of fossil fuels, combustion stoichiometry, air-fuel ratio, excess air, mole and mass flow balance, incomplete combustion, combustion energy, adiabatic flame temperature, flame types, coal combustion process **Combustion systems:** Introduction, combustion systems for solid fuels, fixed bed combustion, bubbling fluidized bed combustion (BFBC), circulating fluidized bed combustion (CFBC), pressurized fluid bed combustion (PFBC), pulverized coal (PC) combustion, combustion systems for gaseous fuels **Power plant emissions and their mitigation:** Emissions in power plants, environmental impact assessment (EIA), flue gas cleaning methods, particulate matters and their cleaning methods, sulfur compounds (SO_x), methods for SO_x reduction, nitrogen oxides (NO_x), methods for NO_x reduction, mitigation options of CO_2 emissions, carbon capture technologies (CCT)
Recommended Prerequisites	• Fundamental and good knowledge and coherent understanding of technology, physics, chemistry, and mathematics (Bachelor's level) • Fundamental and good knowledge of thermodynamics and heat transfer (Bachelor's level)
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	The course documents are provided in the learning management system Moodle.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Mid-term written exam (60 min, worth 50% of the total module grade) • Final written exam (60 min, worth 50% of the total module grade)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	Lectures, exercises, exams
Components to be offered in the Current Semester	**320451** Lecture/Exercise Power Plant Technology 1 - 4 Hours per Term **320480** Examination Power Plant Technology 1

Module 35450 Power Plant Technology 2

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	35450	Compulsory elective

Modul Title	**Power Plant Technology 2** Kraftwerkstechnik 2
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr. rer. nat. Röntzsch, Lars
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	Students will be able to understand the engineering design, operation and maintenance aspects for the components of thermal power plants. They will be able to comprehend various power plant related emissions and their mitigation strategies used.
Contents	**Fundamentals of heat transfer:** Heat transfer mechanisms, Fourier's law, Newton's law of cooling, radiative heat transfer, general heat conduction equations, boundary and initial conditions, heat transfer by conduction cases – plane wall, composite wall, cylinder, concentric cylinder, sphere **Heat exchangers:** Introduction to heat exchangers, classification, LMTD method, effectiveness-NTU method, fouling factor, overall heat transfer coefficient, shell and tube heat exchangers – construction, parts, standards and codes, fluid stream allocations, thermo-hydraulic analysis, KERN method, demonstration by example of KERN method **Pumps:** Introduction to pumps, classification, positive displacement pumps, rotodynamic pumps, characteristics of positive displacement pumps, centrifugal pumps, heads in centrifugal pumps, pump power, efficiency, characteristic curves of centrifugal pumps, priming, cavitation, NPSH, pump operation in parallel and series, sizing of pumps – demonstration by example **Steam generators:** Fundamentals of steam generators, major components, classification, fire tube boilers, water tube boilers, components of water tube boilers, heat absorption in water tube boilers, forced circulation boilers, natural circulation boilers, once-through boilers, economizers, superheaters, air

	preheater, de-superheating and attemperator, supercritical boilers, ultra-supercritical technology, maintenance of steam generators **Introduction to compressible flow and steam turbines:** Fundamentals of compressible flow, Mach number, compressibility, stagnation properties, one-dimensional isentropic flow, nozzles, diffusers, mass flow through converging nozzle, flow in steam nozzles, nozzle efficiency, basics of turbines, classification of steam turbines, impulse and reaction turbines, staging, degree of reaction, compounding, condensing and non-condensing turbines, maintenance of steam turbines **Steam condensers and cooling water system:** Fundamentals of steam condensers, major components, condenser types, direct contact condensers, surface condensers, vacuum in the condenser, vacuum efficiency, sources of air in condensers, condenser efficiency, cooling systems in power plants, circulation, cooling towers, components of cooling towers, performance parameters of a cooling tower, natural and mechanical draft cooling towers **Power plant emissions and their mitigation:** Emissions in power plants, environmental impact assessment (EIA), flue gas cleaning methods, particulate matter and its cleaning methods, sulfur compounds (SO_x), methods for SO_x reduction, nitrogen oxides (NO_x), methods for NO_x reduction, mitigation options for CO_2 emissions, carbon capture technologies (CCT)
Recommended Prerequisites	• Module 35449 "Power Plant Technology 1" • Fundamental and good knowledge and coherent understanding of technical thermodynamics, heat transfer, fluid mechanics, engineering mechanics, and inorganic chemistry (Master's level)
Mandatory Prerequisites	No successful participation in associated phase-out module *35404 Kraftwerkstechnik II*.
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	The course materials are provided in the learning management system Moodle.
Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• Mid-term written exam (60 min, worth 50% of the total module grade) • Final written exam (60 min, worth 50% of the total module grade)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	Lectures, exercises, exams
Components to be offered in the Current Semester	**320481** Examination Power Plant Technology 2

Module 44108 Thermal Process Engineering and Equilibrium Thermodynamics

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	44108	Compulsory elective

Modul Title	**Thermal Process Engineering and Equilibrium Thermodynamics** Thermische Prozesse und Gleichgewichtsthermodynamik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Mauß, Fabian
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	The module provides knowledge about equilibrium thermodynamics and its important technical applications. Based on the fundamentals in thermodynamics of mixtures, the student will learn how to calculate phase equilibria of real multicomponent systems. Upon successful completion of this course, students will be able to calculate equilibrium processes as absorption and extraction. The apparatuses for this separation processes can be dimensioned.
Contents	• pvt behaviour of real fluids • Characterization of mixtures • State laws (virial equations, cubic state laws, generalized state laws) • Activity coefficient models (Wilson, NRTL, UNIQUAC …) • Steam/liquid, liquid/liquid, and solid liquid equilibriums • Thermal separation: absorption
Recommended Prerequisites	Strongly recommended: • Knowledge in mathematics • Physics, thermodynamics • Fundamentals in thermal process engineering
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• Lecture handouts, formulary, exercise materials available on Moodle

- Coulson, John M.: Coulson & Richardson's chemical engineering volume 2. Butterworth-Heinemann, Oxford 2002.
- Felder, Richard M.; Rousseau, Ronald: Elementary principles of chemical processes. Wiley, New York 2000.
- Reid, Robert; Prausnitz, John; Pohling, Bruce: The properties of gases and liquids. McGraw Hill, New York 1987.
- Seader, J. D.; Henley, E.J.: Separation Process Principles. Wiley-VCH, Chichester 2006.
- Hillert, Mats: Phase equilibria, phase diagrams and phase transformations. Cambridge Univ. Press, Cambridge 2008.

Module Examination	Continuous Assessment (MCA)
Assessment Mode for Module Examination	• 10 calculation exercises (50%), • oral test, 30 min (50%)
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	none
Module Components	• Lecture Thermal Process Engineering and Equilibrium Thermodynamics • Exercise Thermal Process Engineering and Equilibrium Thermodynamics
Components to be offered in the Current Semester	**320704** Lecture Thermal Process Engineering and Equilibrium Thermodynamics - 2 Hours per Term **320705** Exercise Thermal Process Engineering and Equilibrium Thermodynamics - 2 Hours per Term **320775** Examination Thermal Process Engineering and Equilibrium Thermodynamics

Module 44407 Technical Combustion

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	44407	Compulsory elective

Modul Title	**Technical Combustion** Technische Verbrennung
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Mauß, Fabian
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	At the end of the module the student are able to describe the chemistry and physics of combustion processes is the aim of the module. Furthermore they can apply their knowledge about laminar and turbulent premixed and diffusion flames.
Contents	The module will analyze the thermodynamics of combustion processes. Thereafter an introduction to chemical kinetics in combustion is given. This includes homogenous gas phase reactions, chain reactions, as well as ignition and extinction processes in homogeneous systems. The last chapter will demonstrate the technical application of the fundamental processes which have been studied in this class.
Recommended Prerequisites	**Strongly recommended:** Fundamental knowledge in mathematics and physics, themodynamics, and heat and mass transfer
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Self organised studies - 120 hours
Teaching Materials and Literature	• Lecture material and exercises available on Moodle • Peters, Norbert: Turbulent Combustion. Cambridge Univ. Press, Cambridge 2000. • Warnatz, Jürgen: Verbrennung - Physikalisch-chemische Grundlagen, Modellierung und Simulation, Experimente, Schadstoffentstehung. Springer-Verlag, Berlin 2001.

- Warnatz, Jürgen; Maas, Ulrich; Dibble, Robert: Combustion - Physical and chemical fundamentals, modeling and simulation, experiments, pollutant formation. Springer-Verlag, Berlin 2006.
- Görner, Klaus: Technische Verbrennungssysteme - Grundlagen, Modellbildung, Simulation. Springer-Verlag, Berlin 1991.
- Stephen R. Turns: An Introduction to Combustion: Concepts and Applications von McGraw-Hill Higher Education, April 2011.

Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	• **Prerequisite**: • Successful completion of the computer lab including lab report (approxm. 10 pages) **Final Module Examination:** • Written examination, 90 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	• All module components will take place via Jitsi.
Module Components	• Lecture Technical Combustion • Exercise Technical Combustion
Components to be offered in the Current Semester	**320706** Lecture Technical Combustion - 2 Hours per Term **320711** Exercise Technical Combustion - 2 Hours per Term **320773** Examination Technical Combustion

Module 44430 Fundamentals in Thermal Process Engineering

assign to: Engineering - Compulsory Elective Modules

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	44430	Compulsory elective

Modul Title	**Fundamentals in Thermal Process Engineering** Grundlagen der Thermischen Verfahrenstechnik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Mauß, Fabian
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	In the module the fundamentals of engineering thermodynamics will be introduced and applied to problems of energy conversion. This also includes equilibrium thermodynamics of ideal mixtures. Furthermore the fundamentals of heat and mass transfer will be teached. Both beeing important in many technical processes within energy conversion and chemical engineering. Upon successful completion of this course, students will have gained working knowledge of basic properties of thermodynamic systems, processes and cycles. Simple heat transfer problems can be solved using either similarity correlations or analytical solutions. The analogy between heat and mass transfer will be understood. The knowledge in thermodynamics and heat and mass transfer will be applied to distillation and rectification processes. In this course the fundamentals in evaluating unit operations in heat transfer and thermal separation processes are trained. The aim of the module is solving praxis relevant problems in thermal process engineering, based on knowledge in phase equilibrium, balancing and transport processes. The student will be trained to select and balance processes and equipment for thermal separation.
Contents	• Properties of thermodynamic systems • First and second law of thermodynamics • Ideal gas law and changes in state of ideal gases • Mixtures of ideal gases, humid air • Phase equilibrium vapour-liquid of ideal mixtures • Conservation of mass, species and energy • Fundamentals of heat transfer (conduction, convective heat transfer, radiation) • Fundamentals of mass transfer (diffusion, convective mass transfer)

	• Working methods and fundamentals in Thermal Process Engineering (terms, balancing, flow diagrams) • Fundamental law in thermodynamics, phase equilibrium, steam-liquid equilibrium of ideal and real mixtures) • Balancing of heat exchanger • Boil down and vaporization of aqueous solutions • Distillation/rectification • Balancing of column apparatus
Recommended Prerequisites	Strongly recommended: • Knowledge in mathematics, physics, thermodynamics
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 2 hours per week per semester Practical training - 3 hours Self organised studies - 117 hours
Teaching Materials and Literature	• Lecture handouts, formulary, exercise materials available on Moodle • Sonntag, Richard Edwin; Borgnakke, Claus: Fundamentals of thermodynamics. Wiley, New York 2003. • Moran, Michael J.; Shapiro, Howard N.: Fundamentals of engineering thermodynamics. Wiley, Chichester 2006. • Incropera, Frank P., De Witt, David P.: Fundamentals of heat and mass transfer. Wiley, New York 2002. • Baehr, Hans Dieter; Stephan, Karl: Heat and mass transfer. Springer, Berlin 2006. • Coulson, John M.: Coulson & Richardson's chemical engineering volume 2. Butterworth-Heinemann, Oxford 2002. • Felder, Richard M.; Rousseau, Ronald: Elementary principles of chemical processes. Wiley, New York 2000. • Seader, J. D.; Henley, E.J.: Separation Process Principles. Wiley-VCH, Chichester 2006.
Module Examination	Prerequisite + Final Module Examination (MAP)
Assessment Mode for Module Examination	**Prerequisite:** • Successful completion of the practical training "rectification" including lab report **Final Module Examination:** • Written examination, 90 minutes
Evaluation of Module Examination	Performance Verification – graded
Limited Number of Participants	none
Remarks	All module components will take place via Adobe Connect.
Module Components	• Lecture Fundamentals in Thermal Process Engineering • Exercise Fundamentals in Thermal Process Engineering
Components to be offered in the Current Semester	**320708** Lecture Fundamentals in Thermal Process Engineering - 2 Hours per Term

320709 Exercise/Practical training
Fundamentals in Thermal Process Engineering - 2 Hours per Term
320774 Examination
Fundamentals in Thermal Process Engineering

Module 11492 Industrial Internship

assign to: Internship

Study programme Power Engineering

Degree	Module Number	Module Form
Master of Science	11492	Mandatory

Modul Title	**Industrial Internship** Industriefachpraktikum
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Dr.-Ing. Ossenbrink, Ralf
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every semester
Credits	12
Learning Outcome	Industrial internship should complement the content of teaching and offer practical application of the theoretical knowledge obtained in the course of studies. It enables the autonomous implementation of the theoretical knowledge and methods acquired in the course of study. The students analyse company processes and the technologies used in a work environment with a predominantly researching, developing, planning or controlling activity character and further develop company processes and technologies with the methods they are familiar with. They are enabled to generate new potential applications or solutions to problems in the field of power engineering. To do this, they work either independently or in a team. At the same time, the internship provides an insight into the technical, economic and social interrelationships of an industrial company. As a result, the students can use the skills they have acquired during the internship in the preparation of their Master's thesis - if it is written afterwards - and in their future careers.
Contents	Industrial internship can be completed at power engineering plans within the country or abroad. Here belong power plant operators, network operators, producers and suppliers of the power engineering equipment as well as corresponding consulting firms. Enterprises and activities should be chosen with respect to the branches of study and aim at the consolidation of the knowledge obtained.
Recommended Prerequisites	Mentoring professor is required.
Mandatory Prerequisites	None
Forms of Teaching and Proportion	Practical training - 300 hours

	Self organised studies - 60 hours
Teaching Materials and Literature	To be provided by the enterprise where an internship takes place
Module Examination	Final Module Examination (MAP)
Assessment Mode for Module Examination	• Successful praparation of an internship report, 5 to 10 pages including certifications as well as presentation of results, 20 minutes
Evaluation of Module Examination	Study Performance – ungraded
Limited Number of Participants	none
Remarks	Duration of the internship 10 weeks up to 6 months. Teaching language German is also allowed.
Module Components	None
Components to be offered in the Current Semester	No assignment

Erläuterungen

Das Modulhandbuch bildet als Teil der Prüfungsordnung die Rechtsgrundlage für ein ordnungsgemäßes Studium. Darüber hinaus soll es jedoch auch Orientierung bei der Gestaltung des Studiums geben.

Dieses Modulhandbuch wurde am 07. November 2025 automatisch für den Master (universitär)-Studiengang Power Engineering (universitäres Profil), PO-Version 2016, aus dem Prüfungsverwaltungssystem auf Basis der Prüfungsordnung generiert. Es enthält alle zugeordneten Module einschließlich der ausführlichen Modulbeschreibungen mit Stand vom 07. November 2025. Neben der Zusammensetzung aller Veranstaltungen zu einem Modul wird zusätzlich das Veranstaltungsangebot für das jeweils aktuelle Semester gemäß dem Veranstaltungsverzeichnis der BTU ausgegeben.

The module catalogue is part of the examination regulation and as such establishes the legal basis for studies according to the rules. Furthermore, it should also give orientation for the organisation of the studies.

This module catalogue was generated automatically by the examination administration system on the base of the examination regulation on the 7 November 2025, for the Master (universitär) of Power Engineering (research-oriented profile). The examination version is the 2016, Catalogue contains all allocated modules including the detailed module descriptions from 7 November 2025. Apart from the composition of all components of a module, the list of lectures, seminars and events for the current semester according to the catalogue of lectures of the BTU is displayed.