Brandenburgische Technische Universität Cottbus - Senftenberg
Platz der Deutschen Einheit 1, 03046 Cottbus

Modulhandbuch für den Studiengang Control of Renewable Energy Systems (universitäres Profil), Master of Science, Prüfungsordnung 2025

Inhaltsverzeichnis

Module 13515 Advanced Methods in Process, Energy and Systems Engineering

assign to: Hydrogen, Geothermal Energy, Storage and Power Networks

Study programme Control of Renewable Energy Systems

Degree	Module Number	Module Form
Master of Science	13515	Compulsory elective

Modul Title	**Advanced Methods in Process, Energy and Systems Engineering** Erweiterte Methoden zur Prozessmodellierung und Optimierung in der Energie- und Verfahrenstechnik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Arellano-Garcia, Harvey
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every summer semester
Credits	6
Learning Outcome	The module requires a basic background in calculus and linear algebra, thus allowing easy understanding of mathematical reasoning. In addition, numerous examples in process, energy, environmental and systems engineering will demonstrate key concepts and algorithms. The practical exercises will involve theoretical derivations and small-size numerical problems in modelling systems like matlab, python, octave, GAMS thus putting knowledge into practice.
Contents	This module will teach approaches to modelling and optimization frameworks to address the complex process and energy problems, which arise in design and operation of process and energy systems in an integrated way. Moreover, the presented theoretical and methodological concepts are joined conceptionally with optimal designed experiments to adjust the fundamental mathematical models and to validate the developed process concepts. The taught methods are of generic character, and thus, producing optimal design and operational plans for process and energy systems ranging from microscale to mega-scale stages over operative time horizons from milliseconds to years. The approaches to be discussed will mainly be around superstructure-based modelling, mixed-integer linear and nonlinear programming, multiobjective optimization, optimization under uncertainty, and life-cycle assessment. The presented case studies will be around advanced process systems for renewable energy conversion, separation and reaction systems as well as biotechnological production systems.

Recommended Prerequisites	• Basic backround in process engineering • calculus and linear algebra
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 zur Vorlesung • Advanced Optimization for Process Systems Engineering. Ignacio E. Grossmann, Cambridge University Press • Optimization for Chemical and Biochemical Engineering: Theory, Algorithms, Modeling and Applications. Vassilios S. Vassiliadis, Walter Kähm, Ehecatl Antonio del Rio Chanona, Cambridge University Press • Systematic Methods of Chemical Process Design. Lorenz T. Biegler, Ignacio E. Grossmann, Arthur W. Westerberg, Prentince Hall • Nonlinear Programming: Concepts, Algorithms, and Applications to Chemical Processes. Lorenz T. Biegler, SIAM, 2010
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 takes place as a block course • The appointment will be announced in the current semester
Module Components	• VL Advance Methods in Process, Energy and systems Engineering • Ü Advance Methods in Process, Energy and systems Engineering • P Advance Methods in Process, Energy and systems Engineering
Components to be offered in the Current Semester	No assignment

Module 13832 Optimisation in Process and Energy Systems Engineering

assign to: Hydrogen, Geothermal Energy, Storage and Power Networks

Study programme Control of Renewable Energy Systems

Degree	Module Number	Module Form
Master of Science	13832	Compulsory elective

Modul Title	**Optimisation in Process and Energy Systems Engineering** Optimierung in der Verfahrens- und Energiesystemtechnik
Department	Faculty 3 - Mechanical Engineering, Electrical and Energy Systems
Responsible Staff Member	Prof. Dr.-Ing. Arellano-Garcia, Harvey
Language of Teaching / Examination	English
Duration	1 semester
Frequency of Offer	Every winter semester
Credits	6
Learning Outcome	After participating in this module, the students master the basic knowledge, in terms of mathematical optimization methods and tools. Relevant examples from Energy and Process Engineering are used to enhance the understanding of the various tools and methods taught. The focus is on the formulation of the problems and the approaches for their mathematical solution. The methods covered are applied in accompanying calculation exercises.
Contents	• Introduction: Definition, problem formulation, applications • Linear programming • Non-linear programming • Mixed integer non-linear programming • Dynamic optimization • Stochastic optimization
Recommended Prerequisites	• Chemical Engineering • Thermodynamics • Process Systems Engineering
Mandatory Prerequisites	none
Forms of Teaching and Proportion	Lecture - 2 hours per week per semester Exercise - 1 hours per week per semester Self organised studies - 135 hours
Teaching Materials and Literature	• T. F. Edgar, D. M. Himmelblau, Optimization of Chemical Processes, McGraw-Hill, New York, 2001

	• L. T. Biegler, I. E. Grossmann, A. W. Westerberg, Systematic Methods of Chemical Process Design, Prentice Hall, New Jersey, 1997 • C. A. Floudas, Nonlinear and Mixed-Integer Optimization, Oxford University Press, 1995 • J. Nocedal, S. J. Wright, Numerical Optimization, Springer, 2006 • R. Baldick, Applied Optimization, Formulation and Algorithms for Engineering Systems, Cambridge University Press, 2006
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	none
Module Components	VL + Ü + Prü Optimization in Process and Energy Systems Engineerin
Components to be offered in the Current Semester	**360331** Lecture/Exercise Optimierung in der Energie- und Verfahrenstechnik/Optimization in Process and Energy Systems Engineering - 3 Hours per Term **360386** Examination Optimization in Process and Energy Systems Engineering

Module 13926 Hydrogen and Fuel Cells

assign to: Hydrogen, Geothermal Energy, Storage and Power Networks

Study programme Control of Renewable Energy Systems

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: Hydrogen, Geothermal Energy, Storage and Power Networks

Study programme Control of Renewable Energy Systems

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 14145 Electrochemical and Chemical Energy Storage and Conversion

assign to: Hydrogen, Geothermal Energy, Storage and Power Networks

Study programme Control of Renewable Energy Systems

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 14181 Master Thesis

assign to: Hydrogen, Geothermal Energy, Storage and Power Networks

Study programme Control of Renewable Energy Systems

Degree	Module Number	Module Form
Master of Science	14181	Mandatory

Modul Title	**Master Thesis** Master-Arbeit
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 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	Students will be admitted to the Master's thesis if they have achieved at least 72 CP at the time of registration for the Master's thesis.
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	The deadline for the written part of the Master's thesis is five months.
Module Components	
Components to be offered in the Current Semester	No assignment

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

assign to: Hydrogen, Geothermal Energy, Storage and Power Networks

Study programme Control of Renewable Energy Systems

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 44108 Thermal Process Engineering and Equilibrium Thermodynamics

assign to: Hydrogen, Geothermal Energy, Storage and Power Networks

Study programme Control of Renewable Energy Systems

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

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 19. September 2025 automatisch für den Master (universitär)-Studiengang Control of Renewable Energy Systems (universitäres Profil), PO-Version 2025, aus dem Prüfungsverwaltungssystem auf Basis der Prüfungsordnung generiert. Es enthält alle zugeordneten Module einschließlich der ausführlichen Modulbeschreibungen mit Stand vom 19. September 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 19 September 2025, for the Master (universitär) of Control of Renewable Energy Systems (research-oriented profile). The examination version is the 2025, Catalogue contains all allocated modules including the detailed module descriptions from 19 September 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.