TECHNISCHE UNIVERSITÄT DRESDEN

Directory of Modules for Visiting Students *Diplom* Programme in Renewable Energy Systems

Faculty of Electrical and Computer Engineering

Information Package for International Visiting and Exchange Students

September 2023

FAKULTÄT ELEKTROTECHNIK UND INFORMATIONSTECHNIK

Description

The Faculty of Electrical and Computer Engineering and the Faculty of Mechanical Science and Engineering at the Technische Universität Dresden offer the **Diplom degree programme in Renewable Energy Systems.** This programme is an integrated five-year (single-tier) programme and thus **includes Bachelor as well as Master's level.**

Structure

The degree programme in Renewable Energy Systems is divided into **basic studies and main studies**.
The **basic studies** include **semester 1-4** (= first and second year of the programme);
the **main studies** include **semester 5-10** (= third until fifth year of the programme).

The programme **comes in modules**. Each module **consists of 1, 2, 3 or 4 parts, i.e. courses**.
Mostly the course name is equivalent to the module name but sometimes it differs.

You must visit all parts/courses of one module!
Also, you have to choose minimum 70% of the modules offered by the Faculty of Electrical and Computer Engineering!

In the following catalogue you will find
- the **modules of our basic studies**, see here
- the **modules of the main studies**, see here.

Language of instruction

The study programme is held in **German**. Students who apply for this study programme should have **German language skills** of at least **B1**.

Specialization areas

Within the **main studies,** there are modules of the following **specialization areas** to choose from:
- Solar energy / Solar
- Geothermal energy / Geothermie
- Wind/Water / Wind/Wasser
- Biomass / Biomasse
- Networks / Netze
- H2 / Wasserstoff
- Energy efficiency / Energieeffizienz

In order to avoid timetable conflicts you should choose from one spezialisation area!

Content of the following module catalogue

1. **Overview of the basic studies modules**, 1st-4th semester, Bachelor level – click here
2. **Overview of the main studies modules**, 5th-10th semester, all specializations – click here
3. **Module descriptions of the basic studies modules** – click here
4. **Module descriptions of the main studies modules** – click here

FAQ

The FAQ shall answer any questions about the module catalogue.

Why is it called modules but not courses?

Each module consists of 1,2, 3 or 4 parts, i.e. courses. Mostly, if it is just one part, the course name is equivalent to the module name.

In which semester are the modules offered?

Please look in the columns “winter semester” / “summer semester”.
The academic year at the TU Dresden is divided into the winter semester (October–March) and summer semester (April–September). The semester dates for the following academic years can be found here.
Our module descriptions inform you in which semester, i.e. winter or summer semester, the respective module is offered. When setting up your learning agreement it is important to consider at first which semester you are coming to the TU Dresden (either the winter or summer semester) and then choose appropriate modules.

What level does the module have?

Please look in the columns “1st semester”, “2nd semester” etc. to find out the semester when it is held. Basic studies are from 1st-4th semester; main studies from 5th-10th semester.

Why are the 7th and 10th semester not indicated?

During the 7th our students conduct a traineeship in companies. In the 10th they write their final thesis.
That is why you see the columns for the 5th, 6th, 8th, 9th semester only.
The **8th** is in **summer semester** and the **9th in winter semester**.
Some modules take two semesters and start in the 8th semester, i.e. summer semester.

Please make sure that you visit the whole module!

How long is an “hour per week”?

An hour per week (German: SWS =Semesterwochenstunde) is one lesson of 45 minutes per week during the teaching period.
At the TU Dresden, **lessons** usually last for **90 minutes**, i.e. one double lesson
(German: Doppelstunde (DS).
1 double lesson (Doppelstunde) = 2 hours per week (Semesterwochenstunde)

What does L/T/P mean?

- L means lecture
- T means tutorial
- P means practical lab course

What does 2/2/0 or 4/4/1 mean?

The **first number** stands for the hours per week for the **lecture**.
The **second number** stands for the hours per week for the **exercise**.
The **third number** stands for the hours per week for the **practical lab course**.

Examples:
2/2/0 = 2 hours per week lectures (90 minutes lecture every week), 2 hours per week tutorial (90 minutes exercise every week), no practical lab course

4/1/1 = 4 hours per week lectures (180 minutes lecture every week), 1 hour (45 minutes) per week tutorial but mostly conducted as 90 minutes every other week, 1 hour (45 minutes) per week practical lab course but conducted as 90 minutes every other week or as block course.

What does "PL" mean"?

It is German for Prüfungsleistung which means assessment.

I have chosen a module – what to do next?

After you have chosen a module you should know which parts are included in the module, in which semester the parts take place, and if a lecture, tutorial and/or practical lab course is included. Furthermore you should search for it in the timetables.

Detailed information you can find on the websites Plan your Studies as well as
Create your timetable.

Note: The English version of our module descriptions is not legally binding.

Overview of the
Basic studies modules 1st-4th semester
(Bachelor level)

Module number, with link to description	**Module name** English German	**1st semester winter semester** L/T/P	**2nd semester summer semester** L/T/P	**3rd semester winter semester** L/T/P	**4th semester summer semester** L/T/P	**Language of instruction**	**ECTS Credits**
RES-G01	Introduction to Analysis and Algebra Algebraische und analytische Grundlagen	6/4/0 PL				German	**11**
RES-G02	Calculus for Functions with Several Variables Mehrdimensionale Differential- und Integralrechnung		4/4/0 PL			German	**9**
RES-G03	Basics of Science Naturwissenschaftliche Grundlagen	2/2/0	2/1/0 PL			German	**7**
RES-G04	Computer Science Informatik	2/1/0 PL	2/0/1 2 PL			German	**6**
RES-G05a	Complex Function Theory Funktionentheorie			2/2/0 PL		German	**4**
RES-G05b	Partial Differential Equations and Probability Theory Partielle Differentialgleichungen und Wahr-scheinlichkeitstheorie				2/2/0 PL	German	**4**
RES-G06	Fundamentals of Electrical Engineering Grundlagen der Elektrotechnik	2/2/0 PL				German	**6**
RES-G07	Electric and Magnetic Fields Elektrische und magnetische Felder		2/2/0 PL			German	**4**
RES-G08	Dynamical Electrical Networks Dynamische Netzwerke			2/2/1 PL	0/0/1 PL	German	**7**
RES-G09	Electrical Power Engineering Elektroenergietechnik			3/1/0 PL	0/0/1 PL	German	**5**
RES-G10	Electronic Circuits Schaltungstechnik				2/1/0 PL	German	**4**

RES-G11	Automation Engineering Automatisierungstechnik				2/1/0 PL	German	**4**
RES-G12	Fundamentals of Renewable Energy Systems Grundlagen Regenerativer Energiesysteme				4/2/0 2 PL	German	**6**
RES-G14	Materials and Engineering Mechanics Werkstoffe und Technische Mechanik	2/1/0 PL	2/2/0 PL			German	**7**
RES-G15	Fundamentals of Kinematics and Kinetics Grundlagen der Kinematik und Kinetik			2/2/0 PL		German	**5**
RES-G16	Technical Thermodynamics Technische Thermodynamik			2/2/0 PL		German	**4**
RES-G17	Heat Exchange Wärmeübertragung				2/2/0 PL	German	**4**
RES-G18	Fluid Mechanics Strömungslehre				2/2/0 PL	German	**5**
RES-G19	Electronic Systems Design Geräteentwicklung		2/2/0 PL			German	**4**
RES-G20	Design Engineering and Manufacturing Engineering Konstruktion und Fertigungstechnik			5/2/0 2 PL	0/2/0 PL	German	**10**

Overview of the
Main studies modules 5th-10th semester
(relevant for all specialization areas)

Module number, with link to description	**Module name** English German	**5th semester** **winter semester** L/T/P	**6th semester** **summer semester** L/T/P	**Language of instruction**	**ECTS Credits**
RES-H01	Specifics of Renewable Energy Systems Vertiefung Regenerativer Energiesysteme		2/2/1 2 PL	German	**6**
RES-H02	Fundamentals of Electrical Power Systems Grundlagen elektrischer Energieversorgungs-systeme	3/2/0 2 PL		German	**5**
RES-H03	Introduction to Energy Economics and Manage-ment BWL/Einführung in die Energiewirtschaft		2/0/0 PL	German	**3**
RES-H04	High Voltage and High Current Engineering Hochspannungs- und Hochstromtechnik	2/1/1 2 PL		German	**5**
RES-H05	Power Electronics Leistungselektronik	2/1/1 2 PL		German	**4**
RES-H06	Electrical Machines Elektrische Maschinen	3/1/0 PL	0/0/1 PL	German	**5**
RES-H07	Control of Continuous Time Processes Regelungstechnik	3/1/0 PL	0/0/1 PL	German	**5**
RES-H08	Measurement and Sensor Techniques Mess- und Sensortechnik	2/0/1 2 PL		German	**4**
RES-H09	Thermodynamics of Processes Prozessthermodynamik	2/2/0 PL		German	**4**
RES-H10	Principles of Fluid Flow Machinery Grundlagen der Fluidenergiemaschinen		4/1/0 2 PL	German	**5**

Overview of the
Main studies modules 5th-10th semester
(Core Modules)

Module number, with link to description	**Module name** English German	**8th semester** **summer semester** L/T/P	**9th semester** **winter semester** L/T/P	**Language of instruction**	**ECTS Credits**
RES-WK-01 **(Solar energy)**	Conversion of Solar Radiation Direkte Konversion Solarstrahlung	4/0/2 2 PL		German	**7**
RES-WK-02 **(Solar energy; Wind/Water)**	Power Electronics for Photovoltaics and Wind Energy Plants Leistungselektronik für Photovoltaik-und Windenergieanlagen	3/2/1 2 PL		German	**7**
RES-WK-03 **(Solar energy)**	Solar Heat Solarthermie		4/1/1 3 PL	German	**7**
RES-WK-04 **(Geothermal energy)**	Geology and Exploration of Natural Energy Resources Geologie und Erschließung	4/2/0 PL		German	**7**
RES-WK-05 **(Geothermal energy)**	Heat Pumps, Organic Rankine Cycles (ORC) and Machinery Wärmepumpen, ORC-Prozesse und Maschinen		4/2/1 3 PL	German	**7**
RES-WK-06 **(Wind/Water)**	Introduction to Numerical Solid and Fluid Mechanics Einführung in die numerische Festkörper- und Fluidmechanik		3/2/1 2 PL	German	**7**
RES-WK-07 **(Wind/Water)**	Lightweight Components of Wind Turbines Leichtbau-Komponenten von Windenergie-anlagen		4/2/0 2 PL	German	**7**
RES-WK-08 **(Wind/Water)**	Calculation of Wind Turbines Berechnung Windenergieanlagen	2/1/0 PL	2/1/0 PL	German	**7**
RES-WK-09 **(Geothermal energy; Wind/Water; Biomass)**	Electromagnetic Energy Conversion Elektromagnetische Energiewandler	4/1/1 2 PL		German	**7**

RES-WK-10 **(Biomass)**	Biomass Sources Biomassebereitstellung	4/1/1 2 PL		German	**7**
RES-WK-11 **(Biomass)**	Biomass for Energy Energetische Biomassenutzung		4/1/2 2 PL	German	**7**
RES-WK-12 **(H2)**	Fuel Cells Brennstoffzellen		4/2/0 PL	German	**7**
RES-WK-13 **(Energy efficiency)**	Electric Drives Elektrische Antriebe	3/1/1 2 PL		German	**7**
RES-WK-21 **(Solar energy; Geothermal energy; Wind/Water; Biomass, Networks; H2; Energy eff.)**	Fundamentals of Energy Storage Grundlagen der Energiespeicherung	4/2/0 2 PL		German	**7**
RES-WK-22 **(Wind/Water)**	Dam Engineering and Hydroelectric Power Engineering Stau- und Wasserkraftanlagen	2/1/0 2 PL	2/1/0 PL	German	**7**
RES-WK-24 **(Wind/Water)**	Chemical Thermodynamics Chemische Thermodynamik		2/2/0 PL	German	**7**
RES-WK-31 **(Solar energy; Geothermal energy; Wind/Water; Biomass, Networks; H2; Energy eff.)**	Network Integration, System Performance and Quality of Supply Netzintegration, Systemverhalten und Versorgungsqualität	3/2/1 3 PL		German	**7**
RES-WK-32 **(Solar energy; Geothermal energy; Biomass, Networks; H2; Energy efficiency)**	Heat Supply Wärmeversorgung		4/1/1 PL	German	**7**
RES-WK-33 **(H2)**	Hydrogen Technologies Wasserstofftechnik		4/2/0 2 PL	German	**7**
RES-WK-41 **(Solar energy; Geothermal energy; Biomass, Networks; H2; Energy efficiency)**	Demand Response Lastmanagement		3/3/0 PL	German	**7**

RES-WK-42 **(Solar energy; Geothermal energy; Wind/Water; Biomass, Networks; H2; Energy efficiency)**	Project Management Projektmanagement	4/2/0 2 PL		German	**7**
RES-WK-43 **(Energy efficiency)**	Process Simulation and Operation Prozessführungssysteme	1/1/0 PL	1/1/2 2 PL	German	**7**
RES-WK-44 **(Energy efficiency)**	Controlled Power Systems Geregelte Energiesysteme		4/1/1 2 PL	German	**7**
RES-WK-45 **(Networks)**	Information and Communication Technologies Informations- und Kommunikationstechnik	4/2/0 2 PL		German or English (language is determined and announced at the beginning of the semester)	**7**
RES-WK-46 **(Energy efficiency)**	Energy efficiency, Energy management, and Environmental law Energieeffizienz, Energiemanagement und Umweltrecht		4/2/0 2 PL	German	**7**

Overview of the
Main studies modules 5th-10th semester
(Complimental Modules)

Module number, with link to description	**Module name** English German	**8th semester summer semester** L/T/P	**9th semester winter semester** L/T/P	**Language of instruction**	**ECTS Credits**
RES-WE-01	Particle Technology for Renewable Energy Systems Partikeltechnologie für RES	3/1/1 3 PL		German	**7**
RES-WE-02	Electromagnetic Compatibility Elektromagnetische Verträglichkeit	3/0/2 2 PL		German	**7**
RES-WE-03	Protection and Control of Electrical Power Systems Schutz- und Leittechnik in elektrischen Energie-versorgungssystemen		3/2/1 3 PL	German	**7**
RES-WE-04	Planning of Electrical Power Systems Planung elektrischer Energieversorgungssysteme	4/3/0 3 PL		German	**7**
RES-WE-05	Specialization High Voltage Engineering Vertiefung Hochspannungstechnik	5/0/1 2 PL		German	**7**
RES-WE-06	Stress of Electrical Equipment Beanspruchung elektrischer Betriebsmittel		3/1/2 3 PL	German	**7**
RES-WE-07	Microprocessor Control in Power Electronics Mikroprozessorsteuerung in der Leistungselektronik	3/2/0 2 PL		German	**7**
RES-WE-09	Design of Power Electronic Systems Entwurf leistungselektronischer Systeme		4/2/0 2 PL	German	**7**
RES-WE-10	Solar Cells Fabrication Technologies Technologien zur Herstellung von Solarzellen	4/2/0 PL		German	**7**
RES-WE-11	Autonomous Microsystems Autonome Mikrosysteme	6/0/0 PL		German	**7**

RES-WE-13	Selected Topics of Electrical Power Engineering Ausgewählte Kapitel der Elektrischen Energie-technik	2/1/0	2/1/0 PL	German	**7**
RES-WE-14	CommunicationTechnology for Thermal and Electrical Power Engineering Kommunikationstechnik in der thermischen und elektrischen Energietechnik		4/1/0 PL	German	**7**
RES-WE-15	Innovative Applications of Energy Storage Systems Methoden und Systemkonzepte für innovative Energiespeicheanwendungen		4/2/0 PL	German	**7**
RES-WE-16	Experimental High Voltage Engineering Experimentelle Hochspannungstechnik		4/0/2 2 PL	German	**7**
RES-WE-17	Optical Process Measurement Optische Prozessmesstechnik	2/0/0	2/0/2 2 PL	German	**7**

Module descriptions
Basic studies modules 1st-4th semester
(Bachelor level)

Module number	Module name	Lecturer in charge
RES-G01	Introduction to Analysis and Algebra	Prof. Dr. rer. nat. habil. Z. Sasvári
Contents and objectives	Contents of the module are set theory, real and complex numbers, sequences of numbers and series, analysis of real functions of a variable, linear spaces and pictures, matrices and determinants, systems of linear equations, eigenvalues and eigenvectors. Outcomes: The students have basic mathematical knowledge and knowledge of algebra. They are capable to calculate with (complex) numbers and to apply functions, sequences and series, vectors (Vector space), determinants and matrizes.	
Modes of teaching and learning	6 hours per week lectures, 4 hours per week tutorials, and self-study	
Prerequisites	Knowledge of mathematics on “Abitur” level or equivalent.	
Requirements for the award of ECTS credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 180 minutes.	
ECTS credit points and grades	11 ECTS credit points The module grade is the grade of the exam.	
Frequency	Annually, in the winter semester	
Workload	330 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-G02	Calculus for Functions with Several Variables	Prof. Dr. rer. nat. habil. Z. Sasvári
Contents and objectives	Contents of the module is the analysis of real functions of several variables, vector analysis, function series (power and Fourier series), differential equations. Outcomes: The students have knowledge of the differentiation and integration of functions with one and more variables, for the analytical solution of differential equations and differential equation systems and for the vector analysis.	
Modes of teaching and learning	4 hours per week lectures, 4 hours per week tutorials, and self-study	
Prerequisites	Competencies acquired in modules such as RES-G01 Introduction to Analysis and Algebra or equivalent.	
Requirements for the award of ECTS credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 150 minutes.	
ECTS credit points and grades	9 ECTS credit points The module grade is the grade of the exam.	
Frequency	Annually, in the summer semester	
Workload	270 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-G03	Basics of Science	Dr. Eduard Lavrov
Contents and objectives	The module covers the main areas of mechanics as well as vibrations and waves from the field of physics. In addition, students can choose either the further particular topics of physics, especially thermodynamics, optics and structure of matter or basic introductions to chemical reactions and processes, especially general and organic chemistry, chemical thermodynamics and electrochemistry, and their practical application. Outcomes: After completing the module, the students understand nature-scientific contexts and their application in the engineering practice. With the thinking and working methods of physics and chemistry they are capable of solving problems in physics and chemistry on their own.	
Modes of teaching and learning	4 hours per week lectures, 3 hours per week tutorials, and self-study	
Prerequisites	Knowledge of physics and chemistry on “Abitur” level or equivalent.	
Requirements for the award of ECTS credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 180 minutes.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade of the exam.	
Frequency	Annually, beginning in the winter semester	
Workload	210 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
RES-G04	Computer Science	Prof. Dr.-Ing. Diana Göhringer
Contents and objectives	The module covers the areas of construction and programming of computers. This includes information presentation, Boolean basic circuits, arithmetic units, memory and control units as well as basic concepts of simple calculators and assembler programming, object-oriented programming and alternative programming paradigms. After completing the module the students have competencies and practical skills in the evaluation and design of computer circuits and processor architecture. They are able to program computer at low abstraction level in assembler and at a high level of abstraction in an object-oriented programming language.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical lab course, and self-study.	
Prerequisites	Knowledge of mathematics on “Abitur” level or equivalent.	
Requirements for the award of ECTS credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of two written exams of 120 minutes each and an ungraded project work.	
ECTS credit points and grades	6 ECTS credit points If the project work is evaluated as “passed”, the module grade is the weighted mean of the two exams. If the project work is evaluated as “not passed”, the module grade is the weighted mean of the exams as follows: M = (2·PL1 + 2· PL2 + 6 ·5) / 10.	
Frequency	Annually, beginning in the winter semester	
Workload	180 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
RES-G05a	Complex Function Theory	Prof. Dr. rer. nat. habil. Z. Sasvári
Contents and objectives	Content of the module is the function theory with the main focus on differentiation, integration, series development and conformal transformation. Outcomes: The students have knowledge of functions with complex variables.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week tutorials, and self-study.	
Prerequisites	Competencies acquired in modules such as RES-G01 Introduction to Analysis and Algebra, RES-G02 Calculus for Functions with Several Variables or equivalent.	
Requirements for the award of ECTS credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 120 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade is the grade of the exam.	
Frequency	Annually, in the winter semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-G05b	Partial Differential Equations and Probability Theory	Prof. Dr. rer. nat. habil. Z. Sasvári
Contents and objectives	The content of the module focuses on partial differential equations and probability theory. Outcomes: After completion of the module, the students have knowledge of special analytical solution methods of partial differential equations and probability theory.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week tutorials, and self-study.	
Prerequisites	Competencies acquired in modules such as RES-G01 Introduction to Analysis and Algebra, RES-G02 Calculus for Functions with Several Variables or equivalent.	
Requirements for the award of ECTS credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 120 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade is the grade of the exam.	
Frequency	Annually, in the summer semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-G06	Fundamentals of Electrical Engineering	Prof. Dr. phil. nat. habil. Ronald Tetzlaff
Contents and objectives	Content: The calculation of direct current (DC) electrical networks Objectives: Having successfully completed this module, the students have basic knowledge of electrical engineering and electronics and master methods for solving electrical engineering problems as a basis for further modules. The focus is on resistive circuits. Students are able to describe linear and nonlinear two poles and to consider the temperature dependence of their parameters, to analyze systematically electrical DC circuits and to apply simplified analysis methods (two pole theory, superposition theorem). They are able to calculate the power dissipation in circuits as well as to analyze and determine their thermal behaviour.	
Modes of teaching and learning	2 hours per week lecture, 2 hours per week tutorial, and self-study	
Prerequisites	Basic knowledge in mathematics and physics on "Abitur" level or equivalent.	
Usability	The module is a compulsory module of the basic studies in the Diplom degree programmes in Electrical Engineering, Information Systems Technology, Mechatronics, and Renewable Energy Systems. It is designed to enable the students to pass the module exam of the module Dynamic Networks.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 150 minutes.	
ECTS credit points and grades	6 ECTS credit points The module grade is the grade of the written exam.	
Frequency	Annually, in the winter semester	
Workload	180 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-G07	Electric and Magnetic Fields	Prof. Dr. phil. nat. habil. Ronald Tetzlaff
Contents and objectives	Content: The modules deals with the fundamenals for calculating basic electric and magnetic fields Objectives: After successfully completing this module, the students are able to master fundamental terms, concepts and methods for the calculation of basic electric and magnetic fields. They are able to calculate the stored field energy, force effects, and induction phenomena of magnetic fields. They are familiar with the basic principles of the electronic components resistor, capacitor, inductor, and transformer.	
Modes of teaching and learning	2 hours per week lecture, 2 hours per week tutorial, and self-study	
Prerequisites	Competences acquired in modules on Principles of Algebra and Analysis and basic modules on Physics as well as competences acquired in modules such as RES-G06 Basic Electrical Engineering, RES-G01 Introduction to Analysis and Algebra and RES-G03 Basics of Science or equivalent.	
Usability	The module is a compulsory module of the basic studies in the Diplom degree programmes in Mechatronics and Renewable Energy Systems. It is designed to enable the students to pass the module exam of the module Dynamic Networks.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 150 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade is the grade of the written exam.	
Frequency	Annually, in the summer semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-G08	Dynamical Electrical Networks	Prof. Dr. phil. nat. habil. Ronald Tetzlaff
Contents and objectives	The module contents: the analysis of linear dynamic networks. Outcomes: After completing this module, students are able to apply methods for analyzing linear dynamic circuits excited by periodic signals and to determine the transient behavior between stationary states. They are able to describe, to model and to analyze linear two-ports. They can determine transfer functions, analyze and graphically represent the network behavior for different frequencies, and determine basic filter structures. Phasor representations and Nyquist plots are mastered.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week tutorial, 2 hours per week practical lab course, and self-study.	
Prerequisites	Knowledge acquired in modules such as RES-G06 Basic Electrical Engineering, RES-G01 Introduction to Analysis and Algebra, RES-G02 Calculus for Functions with Several Variables, RES-G03 Basics of Science or equivalent. The prerequisite for participation in the lab coursein the winter semester is to pass the module exam of the module RES-G06 Basic Electrical Engineering. The prerequisite for participation in the lab course in the summer semester is to pass the module exam of the module RES-G06 Basic Electrical Engineering and RES-G07 Electric and Magnetic Fields.	
Requirements for the award of ECTS credit points	The credit points are awarded if the module assessment is passed. The module assessment consists of a written exam of 150 minutes and a lab course. Both assessments must be passed.	
ECTS credit points and grades	7 ECTS credit points The module grade is determined by the weighted average of the grades of both elements of assessment. The module grade consists to 2/3 of the grade of the written exam and to 1/3 of the lab course grade.	
Frequency	Annually, starting in the winter semester	
Workload	210 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
RES-G09	Electrical Power Engineering	Prof. Dr.-Ing. P. Schegner
Contents and objectives	Contents: - Generation, transformation, transport, distribution and usage of electrical energy - Structure of electrical energy supply - Fundamentals of three-phase power and their mathematical description - Electrical safety and coordination of stress and strength - Fundamentals of power electronics - Electromechanic energy converters Objectives: Having successfully completed this module, the students are able to undertake basic calculations and measurements for simple three-phase systems. They are familiar with principles of safety measures in electrical networks. They are able to calculate simple insulation configurations. The students are familiar with the fundamental mode of operation of power electronic circuits, electrical machines and three-phase transformers.	
Modes of teaching and learning	3 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical lab course, and self-study	
Prerequisites	None	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 150 min. (PL1) and a lab course (PL2). Both elements of assessment have to be passed.	
ECTS credit points and grades	5 ECTS credit points The module M grade is calculated as follows: M = (2PL1 + PL2)/3	
Frequency	Annually, in the winter semester	
Workload	150 working hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
RES-G10	Electronic Circuits	PD Dr.-Ing. habil. V. Müller
Contents and objectives	Content: The module deals with the mode of operation, dimensioning and characteristics of electronic circuits of analogue and digital technology. Based on the circuit properties of diodes and transistors, much attention is paid to the analysis of basic circuits in the low frequency range. Analysis of basic circuits in the low frequency range on the basis of circuit properties of diodes and transistors Objectives: The students are able to dimension simple transistor circuits. They are able to analyse complex circuits on the basis of familiar properties of elementary circuits, they are familiar with the methodology of the design of amplifier circuits in the time and frequency domain. Further, they master the analysis and design of digital control and signal processing based on combinatorial and sequential circuit assemblies.	
Modes of teaching and learning	2 hours per week lecture, 1 hour per week tutorial, and self-study	
Prerequisites	Competences acquired in basic modules on Physics such as RES-G03 Basics of Science as well as in modules such as RES-G06 Basic Electrical Engineering, Systems Theorie and RES-G11 Automation Engineering and Measurement and RES-H07 Control of Continuous Time Processes or equivalent.	
Usability	This module is a compulsory module within the Diplom degree programmes in Mechatronics and Renewable Energy Systems.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment is a written exam (120 min).	
ECTS credit points and grades	4 ECTS credit points The module grade is the grade of the written exam.	
Frequency	Annually, in the summer semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-G11	Automation Engineering	Prof. Dr. techn. K. Janschek
Contents and objectives	Content: 1. Fundamentals of automation engineering wit the focus on behavioural description, control design in the frequency domain, digital control loops, industrial standard controllers, discrete-event control systems, elementary control concepts and automation technologies 2. Fundamentals of measuring with the focus on measurement principles, SI units, analogue measurement technology (fundamentals, measurement bridges, lock-in measurement technique, quadrature demodulation technique, measurement of transit times and distances) and statistical measurement data evaluation (calculation of standard deviation and confidence intervals, propagation of the measurement uncertainty, setup of uncertainty budget for measurement) Objectives: Having successfully completed the modules, the students 1. understand fundamental behaviour description forms for technical systems. Further, they master the basic theoretical and computer-aided handling of linear, time-invariant and discrete-event behaviour models for the control of technical systems. They are able to design control algorithms for simple tasks. 2. are familiar with the principles of analogue measuring procedures and are able to evaluate measurement results by using statistical methods. They are able to calculate and interpret random and systematic measuring uncertainties.	
Modes of teaching and learning	2 hours per week lecture, 1 hour per week tutorial, and self-study	
Prerequisites	Competences acquired in basic modules on Physics such as RES-G03 Basics of Science or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 120 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade is the grade of the written exam.	
Frequency	Annually, in the summer semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-G12	Fundamentals of Renewable Energy Systems	Prof. Dr.-Ing. Clemens Felsmann
Contents and objectives	Content: The module includes an overview of the technical and economic options for using solar energy, geothermal energy, wind and water power and biomass. The focus is on the use of these energy sources and technical solutions in Central Europe and their assessment, taking into account the state of the art and the technical and economic development potential. The content of the module also includes the general conceptual and methodological foundations for the description (representation, modeling) of dynamic processes in nature and technology. The focus is on methods for the investigation of static and dynamic systems. Objectives: 1. Fundamentals of regenerative energy sources: the students have basic knowledge of the potential and possible uses of renewable energy systems (operating principles, parameters, economy and environmental aspects). 2. Systems theory: based on essential terms such as mapping and state students can observe static and dynamic systems from a uniform point of view and describe them mathematically. The focus of the knowledge imparted is on the properties of linear dynamic time-continuous and time-discrete systems in the time and image area (Fourier, Laplace or z area).	
Modes of teaching and learning	4 hours per week lecture, 2 hours per week tutorial, and self-study	
Prerequisites	Competences acquired in modules such as RES-G16 Technical Thermodynamics, RES-G01 Introduction to Analysis and Algebra, RES-G02 Calculus for Functions with Several Variables, RES-G06 Basic Electrical Engineering and RES-G07 Electric and Magnetic Fields or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of two exams. Examination 1: Written exam K1 for objective 1 (basics of regenerative energy sources) in the amount of 90 minutes. If there are fewer than 20 participants, the written exam will be replaced by an oral exam as a group exam with up to 3 people of 20 minutes each; if applicable, this will be announced to the registered students at the end of the registration period as is customary in the faculty. Examination 2: Written exam K2 for objective 2 (systems theory) for 90 minutes.	
ECTS credit points and grades	6 ECTS credit points The module grade is the arithmetic mean of the grades of the written exams.	
Frequency	Annually, in the summer semester	

Workload	180 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
RES-G14	Materials and Engineering Mechanics	Prof. Dr.-Ing. habil. J. Bauch
Contents and objectives	Content: Materials with focus on: 1. Overview of materials in Electrical Engineering and Mechatronics, practical examples 2. Fundamentals of materials science 3. Status diagrams and alloys 4. Conductor, semiconductor, dielectric and magnetic materials 5. Materials testing and diagnostics Statics and science of strength of materials with focus on: 1. Rigid bodies 2. Independent loads, power and torque, method of sections 3. Balance of planar structures (balances of forces and moments) 4. Tensile, compressive and shear stresses including elementary dimensioning concepts 5. Torsion of bars with circular cross-section, straight bending of prismatic beams, strength theories and bar buckling Objectives: Having successfully completed this module, the students are familiar with the interrelation between the microscopic structure, the macroscopic properties and the practical aspects of application of materials. They know the theoretical principles of the atomic structure, the bond type, the crystal structure, the real structure as well as the microstructure and are familiar with material testing. Further, they are familiar with the fundamental laws of statics as well as the simplified interrelation between loads, material properties and loads of components. With regard to these topics, they master calculation methods of the structural design and strength evaluation.	
Modes of teaching and learning	4 hours per week lecture, 3 hours per week tutorial, and self-study	
Prerequisites	Knowledge in mathematics and physics from higher education and from module such as RES-G01 Introduction to Analysis and Algebra or equivalent.	
Usability	The module is a compulsory module within the basic studies of the Diplom programme in Mechatronics, Electrical Engineering and Renewable Energy Systems.	
Requirements for the award of ECTS credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 90 min. (K1) and a written exam of 120 min. (K2, 120 min.). Both elements of assessment must be passed.	
ECTS credit points and grades	7 ECTS credit points The module grade M is calculated as follows: M = (3PL1 + 4PL2)/7	

Frequency	Annually, starting in the winter semester
Workload	210 hours
Duration	2 semesters

Module number	Module name	Lecturer in charge
RES-G15	Fundamentals of Kinematics and Kinetics	Prof. Dr.-Ing. habil. V. Ulbricht
Contents and objectives	Content: The module focuses on: - Kinematics of the point and the rigid body - Kinetics of rigid bodies in translation - Kinetics of a rigid body with arbitrary motion, momentum and angular momentum balance (including cutting principle, static interpretation of the momentum balances, free planar motion - Vibrations of systems with different degree of freedom - Lagrange equations of the second kind - Spatial rotor movements Objectives: The students are familiar with analytical methods for the analysis of rigid body motions, including the causative loads.	
Modes of teaching and learning	2 hours per week lecture, 2 hours per week tutorial, and self-study	
Prerequisites	Knowledge in the fields of RES-G01 Introduction to Analysis and Algebra, RES-G02 Calculus for Functions with Several Variables or equivalent, as well as specific chapters of mathematics and the module RES-G14 Materials and Engineering Mechanics or equivalent.	
Usability	The module is a compulsory module within the basic studies for the *Diplom* programme in Mechatronics and Renewable Energy Systems.	
Requirements for the award of ECTS credit points	The credit points are awarded when the module assessment is passed. The module assessment is a written exam of 120 minutes.	
ECTS credit points and grades	5 ECTS credit points The module grade is the grade of the written exam.	
Frequency	Annually, in the winter semester	
Workload	150 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-G16	Technical Thermodynamics	Prof. Dr. C. Breitkopf
Contents and objectives	Having successfully completed this module, the students have basic knowledge of the properties of thermodynamic systems, state variables (internal energy, enthalpy, entropy, etc.), process variables (work, heat) and state changes (isochoric, isobaric, isothermal, isentropic, polytropic) and the application of basic thermodynamic knowledge of ideal gases, gas mixtures, balancing (1st and 2nd law), moist air, and simple thermodynamic processes (reversible and irreversible).	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week tutorials, and self-study	
Prerequisites	Competences acquired in modules such as RES-G01 Introduction to Analysis and Algebra, RES-G02 Calculus for Functions with Several Variables and RES-G03 Basics of Science or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 120 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade is the grade of the written exam.	
Frequency	Annually, in the winter semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-G17	Heat Exchange	Prof. Dr.-Ing. M. Beckmann
Contents and objectives	Basic knowledge of the transport laws for thermal energy (conduction, convection, radiation) is acquired. Contents are the basics for the phenomenological description of the mechanisms of conduction, convection and radiation and, based on this, their application to stationary and instationional problems of heat conduction, the heat transfer to ribs, the heat transfer of multilayered bodies (plate, cylinder, ball), the calculation of heat exchangers and the optimization of heat transfer processes.	
Modes of teaching and learning	2 hours per week lectures, and 2 hours per week tutorials.	
Prerequisites	Competences acquired modules RES-G01 Introduction to Analysis and Algebra, RES-G02 Calculus for Functions with Several Variables and RES-G03 Basics of Science, and RES-G16 Technical Thermodynamics or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 120 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade is the grade of the written exam.	
Frequency	Annually, in the summer semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-G18	Fluid Mechanics	Prof. Dr.-Ing. habil. J. Fröhlich
Contents and objectives	Content: • Fundamentals of the mechanics of gases and fluids, • Conservation laws of classical mechanics in differential and integral form, • one-dimensional current thread theory for incompressible and compressible fluids including their use for technically relevant configurations, • laminar and turbulent flows. Objectives: Having successfully completed the modules, the students have a basic understanding of the mechanics of gases and fluids. They are able to analyze simple technical flow configurations and describe them quantitatively.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week tutorials, and self-study	
Prerequisites	Competences acquired modules RES-G01 Introduction to Analysis and Algebra, RES-G02 Calculus for Functions with Several Variables and RES-G03 Basics of Science, or equivalent. A manuscript is available for preparation for the module.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 150 minutes.	
ECTS credit points and grades	5 ECTS credit points The module grade is the grade of the written exam.	
Frequency	Annually, in the summer semester	
Workload	150 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-G19	Electronic Systems Design	Prof. Dr.-Ing. habil. J. Lienig
Contents and objectives	Content: The module focuses on constructional fundamentals with technical illustration and CAD, device design and device requirements, reliability of electronic systems, thermal dimensioning and electromagnetic compatibility. Objectives: Students completing this module obtain basic knowledge for the construction and development of electronic assembly groups and devices. They will have an understanding of engineering tasks as well as related requirements. Thus, the students will be enabled to follow engineering principles while developing and constructing such products under consideration of all relevant aspects.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week tutorial, and self-study	
Prerequisites	none	
Usability	This module is a compulsory module for the basic studies within the Diplom programmes in Electrical Engineering, Mechatronics, and Renewable Energy Systems.	
Requirements for the award of ECTS credit points	The credit points are obtained by passing the module assessment. This assessment is conducted as a written exam (120 minutes).	
ECTS credit points and grades	4 ECTS credit points The module grade is the grade of the written exam.	
Frequency	Annually, during the summer semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-G20	Design Engineering and Manufacturing Engineering	Prof. Dr.-Ing. B. Schlecht
Contents and objectives	Content: The module covers the fundamentals of the calculation of the load bearing capacity of simple components and also includes the variety of manufacturing processes in mechanical engineering, vehicle and plant construction by means of product and process examples. It integrates engineering thinking and working methods in the manufacturing process as well as the interaction with other disciplines. Objectives: Having successfully completed this module, the students 1. have the essential basic knowledge of the development, design, manufacture and testing of mechanical engineering products as well as skills in dealing with CAD systems. 2. can estimate, select and calculate the areas of application of typical machine elements such as axes and shafts, elementary connections, non-positive and positive shaft-hub connections, roller bearings, plain bearings and gear drives. 3. know which areas of a company are involved in the manufacture of products, which requirements of the product determine the manufacturing possibilities and how manufacturing decisions are derived. 4. know the manufacturing processes, in particular their operating principles, the technical equipment and the technological parameters to be determined.	
Modes of teaching and learning	4 hours per week lecture, 4 hours per week tutorial, and self-study	
Prerequisites	Knowledge in the fields of RES-G01 Introduction to Analysis and Algebra, RES-G02 Calculus for Functions with Several Variables, RES-G14 Materials and Engineering Mechanics as well as RES-G19 Electronic Systens Designor equivalent.	
Usability	The module is a compulsory module within the *Diplom* programme in Mechatronics and Renewable Energy Systems.	
Requirements for the award of ECTS credit points	The credit points are awarded if the module assessment is passed. The module assessment consists of 1. a written exam (K1, 90 min) on objectives 3 and 4 2. a written exam (K2, 180 min.) on objective 1 and 2. 3. A design assignment (B) All elements of assessment have to be passed.	
ECTS credit points and grades	10 ECTS credit points The module grade M is calculated as follows: M = (3K1 + 4K2 + 3B)/10	
Frequency	Annually, starting in the winter semester	
Workload	300 hours	

Duration	2 semesters

Module descriptions
Main studies modules 5th-10th semester
(relevant for all specialization areas)

Module number	Module name	Lecturer in charge
RES-H01	Specifics of Renewable Energy Systems	Prof. Dr.-Ing. C. Felsmann
Contents and objectives	The content of the module is the integration of renewable energy sources into higher-level energy systems. This includes general and in-depth questions of the constructive plant design, the technical-economic problems of the design, the evaluation and the operation of plants for the use of regenerative energy sources. In particular, the combination with conventional energy systems based on fossil fuels is dealt with. A further focus is on the basics of refrigeration technology, including regenerative refrigeration, and the introduction to the associated systems of refrigeration, air conditioning and heat pump technology. Qualification goals: 1. The students have knowledge of interpretation, application development and evaluation of regenerative energy systems (switching systems, plant technology and operation) 2. The students master the basics of refrigeration technology, in particular regenerative refrigeration.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week tutorials, 1 hour per week practical lab courses, and self-study.	
Prerequisites	Competences acquired in modules such as RES-G12 Fundamentals of Renewable Energy Systems and RES-G18 Fluid Mechanics, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. If there are more than 10 participants, it consists of a K1 written test of 120 minutes and the practical lab course P. If there are up to 10 participants, the written test is replaced by an oral examination as a group test with up to 3 people of 20 minutes each. if applicable, this will be announced to the registered students at the end of the registration period as is customary in the faculty.	
ECTS credit points and grades	6 ECTS credit points The module grade M is calculated from the grades of the examination according to $M = 0.75 \cdot K1 + 0.25 \cdot P$.	

Frequency	Annually, in the summer semester
Workload	180 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
RES-H02	Fundamentals of Electrical Power Systems	Prof. Dr.-Ing. P. Schegner
Contents and objectives	Contents: - Function, parameter estimation and modeling of all important equipment in electrical distribution networks - Simplified methods for the calculation of voltage and current distribution as well as the basic aspects of design and dimensioning of electrical systems Intended learning outcome: Upon successful completion of the module, students are able to create and apply models for equipment in the electrical power system. They have the skills to determine the parameters for the most important equipment from geometrical data, manufacturer's specification or with the help of measurements. The students are familiar with the basics of dimensioning of electrical equipment.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week tutorials, and self-study.	
Prerequisites	Competences acquired in modules such as RES-G06 Fundamentals of Electrical Engineering, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of two written exams of 120 minutes and 90 minutes.	
ECTS credit points and grades	5 ECTS credit points The module grade consists to 2/3 of the grade for the exam of 120 min. and to 1/3 of the grade for the exam of 90 min.	
Frequency	Annually, in the winter semester	
Workload	150 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-H03	Introduction to Energy Economics and Management	Prof. Dr. habil. D. Möst
Contents and objectives	The student • will be able to masters the methods of investment calculation, can evaluate investment projects with regard to their economic advantages and make well-founded decisions, • can characterize and evaluate the different energy sources (coal, gas, oil, electricity, heat etc.) and their peculiarities (reserves, providers, costs, technologies), • knows the framework of energy policy and is able to understand the context of the energy industry, • is capable of ecological effects of the energy supply assessment.	
Modes of teaching and learning	2 hours per week lectures and self-study.	
Prerequisites	None.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 90 minutes.	
ECTS credit points and grades	3 ECTS credit points The module grade results from the grade of the written test.	
Frequency	Annually, in the summer semester	
Workload	90 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-H04	High Voltage and High Current Engineering	Prof. Dr.-Ing. S. Großmann
Contents and objectives	The module contains basics and principles of - High voltage engineering - High current engineering Qualification: After successful completion of the module, the students will be able to comprehend the operating behaviour of components in an electrical power supply network. Furthermore the students will be able to evaluate the stress of a component by electrical and mechanical loads by means of proper measurements and tests.	
Modes of teaching and learning	2 hours per week lectures, 1 hour per week tutorial/seminar, 1 hour per week practical lab course and self-study	
Prerequisites	Competences acquired in modules such as RES-G06 Fundamentals of Electrical Engineering and RES-G03 Basics of Science or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module examination consists of a written exam PL1 of 90 minutes and a practical lab course PL2. For up to 20 participants, the written exam is replaced by an oral exam as a group exam with up to 3 people, each lasting 30 minutes. Both exams have to be passed.	
ECTS credit points and grades	5 ECTS credit points The module consists to 70% of the oral exam grade/the written exam grade and to 30% of the lab course grade.	
Frequency	Annually, in the winter semester	
Workload	150 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-H05	Power Electronics	Prof. Dr.-Ing. St. Bernet
Contents and objectives	Content: 1. Structure and mode of operation of active power semiconductor components and power diodes, 2. analysis of the functioning of line and self-guided circuits, 3. simplification of the systems under consideration for the purpose of simulation, 4. interpretation of the core components of the power electronics subsystem, 5. modulation methods for controlling power electronic regulator control elements Objectives: The students 1. are familiar with the mode of operation and methods for the analysis of basic power electronic topologies and semiconductor components 2. are able to select and dimension appropriate circuits. Further, they are able to select and interpret power semiconductor devices for power electronic systems in typical applications. 3. are able to verify the basic function of the observed power electronic subsystem with means of simulation tools.	
Modes of teaching and learning	2 hours per week lecture, 1 hour per week tutorial, 1 project, and self-study	
Prerequisites	Competences acquired in modules such as RES-G06 Fundamentals of Electrical Engineering or equivalent.	
Usability	This module is a compulsory module within the Diplom degree programmes in Mechatronics and Renewable Energy Systems.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a project (PA, 30 Stunden) and a written exam (K, 120 min).	
ECTS credit points and grades	4 ECTS credit points The module grade M is calculated as follows: M= (4K + PA)/5	
Frequency	Annually, in the winter semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-H06	Electrical Machines	Prof. Dr.-Ing. W. Hofmann
Contents and objectives	Content: **Fundamentals of electrical machines** in structure, function, performance, agitator speed or power setting and efficiency - Fundamentals of electromagnetic energy conversion - Transformers - DC maschines - Synchronous machines - Induction machines - Small machines - Linear motors - Testing of electrical machines Objectives: Having successfully completed the module, the students can follow the steady-state operating performance of electrical machines and evaluate their properties by means of suitable calculations, measurements and tests.	
Modes of teaching and learning	3 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical lab course, and self-study	
Prerequisites	Competences acquired in modules such as RES-G06 Fundamentals of Electrical Engineering and RES-G03 Basics of Science or equivalent.	
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module examination consists of a written exam PL1 of 180 minutes and a lab course P.	
ECTS credit points and grades	5 ECTS credit points The module grade is the weighted average of both elements of assessment. The grade of the written exam contributes by 70% and the grade of the lab course by 30%.	
Frequency	Annually, starting in the winter semester	
Workload	150 hours	
Duration of module	2 semesters	

Module number	Module name	Lecturer in charge
RES-H07	Control of Continuous-Time Processes	Prof. Dr.-Ing. habil. K. Röbenack
Contents and objectives	Content: Fundamentals of control of linear systems (basic structures of control, signal and system descriptions, stability analysis, controller design in the frequency range), fundamentals of behavioural description of discrete event systems (signal-based, finite automata, Petri nets) and for the design of discrete event control systems (bottom-up, top-down automata and Petri nets), examples of laboratory-based control systems Objectives: Having successfully completed the module, the students will be able to 1. understand the basic structure of controls. They are able to describe linear systems mathematically and to analyse these with regard to their stability. Further, they are able to design single-loop linear controllers. 2. are able to solve control problems on real technical-physical systems.	
Modes of teaching and learning	3 hours per week lectures, 1 hours per week tutorials, 1 hour per week lab courses, and self-study	
Prerequisites	Competences acquired in modules such as RES-G11 Automation Engineering, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam (K1, 120 min.) on objective 1, a lab course (P) on objective 2.	
ECTS credit points and grades	5 ECTS credit points The module grade M is calculated as follows: $M = 0.8 \cdot K1 + 0.2 \cdot P$	
Frequency	Annually, starting in the winter semester	
Workload	150 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
RES-H08	Measurement and Sensor Techniques	Prof.Dr.rer.nat. St. Odenbach
Contents and objectives	The module includes measurement principles, methods and procedures for expansion, temperature, flow and sound and includes the necessary interpositions as well as the description of the dynamic behavior of measuring elements. The students will be able to master the basic principles and the practical implementation of measurement and sensor methods. The students are able to present and assess the physical principle and the technical design of measuring and sensor methods under real conditions. They are familiar with calculation methods for measurement uncertainty.	
Modes of teaching and learning	2 hours per week lectures, 1 hour per week lab courses, and self-study.	
Prerequisites	Competences acquired in modules such as RES-G03 Basics of Science, RES-G01 Introduction to Analysis and Algebra, RES-G02 Calculus for Functions with Several Variables, RES-G06 Fundamentals of Electrical Engineering, RES-G14 Materials and Engineering Mechanics RES-G15 Fundamentals of Kinematics and Kinetics RES-G18 Fluid Mechanics and RES-G17 Heat Exchange, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 150 minutes and lab course P.	
ECTS credit points and grades	4 ECTS credit points The module grade results from the grades of the examinations according to the following formula: $M = 0.75 \cdot K + 0.25 \cdot P$	
Frequency	Annually, in the winter semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-H09	Thermodynamics of Processes	Prof. Dr. rer. nat. habil. C. Breitkopf
Contents and objectives	This module contains the basics of thermodynamic cycle processes and technical combustion. The students will be able to master the calculation of relevant systems in energy technology and know basic processes in gas turbine, steam and heating power plants and refrigeration machines. He is able to calculate and evaluate specific plant circuits and to be able to classify them in terms of the overall energy economy.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week tutorials, and self-study.	
Prerequisites	Competences acquired in modules such as RES-G01 Introduction to Analysis and Algebra, RES-G02 Calculus for Functions with Several Variables, RES-G03 Basics of Science and RES-G16 Technical Thermodynamics or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 150 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade results from the grade of the written exam.	
Frequency	Annually, in the winter semester	
Workload	150 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-H10	Principles of Fluid Flow Machinery	Prof. Dr.-Ing. U. Gampe
Contents and objectives	The module covers the basics of turbo and piston machines. This applies to the types and areas of application of these machines, the basics of energy conversion, design, construction and operating behavior. The students will master the selection of suitable fluid energy machines for specified operating conditions and operating parameters. This includes the type and number of stages, the determination of the main dimensions, the rough design of the most important functional elements and the consideration of energy conversion losses as well as the interaction of the energy machine and system. The student will be able to solve typical engineering tasks that are typically interdisciplinary due to their thermodynamic, fluid, structural and material-technical aspects.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorials, and self-study.	
Prerequisites	Competences acquired in modules such as RES-G18 Fluid Mechanics, RES-G16 Technical Thermodynamics, RES-G14 Materials and Engineering Mechanics and RES-G20 Design Engineering and Manufacturing Engineering, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of two written exams (K1 and K2) of 90 minutes each.	
ECTS credit points and grades	5 ECTS credit points The module grade results from the grades of the examinations according to the following formula: $M = 0.5 \cdot K1 + 0.5 \cdot K2$	
Frequency	Annually, in the summer semester	
Workload	150 hours	
Duration	1 semester	

Module descriptions
Main studies modules 5th-10th semester
(Core Modules)

Module number	Module name	Lecturer in charge
RES-WK-01	Conversion of Solar Radiation	Prof. Dr. rer. nat. habil. J. Weber
Contents and objectives	Content: • radiation from the sun, its formation and absorption in matter • Physical basics of direct energy conversion in photovoltaics and solar thermal • Materials and process steps in the manufacture of solar cells and solar modules • Basic principles of various solar thermal collector systems, modeling of conversion processes and yield calculations Qualification goals: The students will know the basic physical processes of energy conversion of solar radiation into electrical and heat energy and are able to use them in the optimization of photovoltaic and solar thermal systems. The students will have practical experience with semiconductor process steps.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week lab courses.	
Prerequisites	Competences acquired in modules from RES-G01 Introduction to Analysis and Algebra, RES-G02 Calculus for Functions with Several Variables, RES-G03 Basics of Science, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam K of 90 minutes and the lab course P.	
ECTS credit points and grades	7 ECTS credit points The module grade results from the grades of the examinations according to the following formula: $M = 2/3 \cdot K1 + 1/3 \cdot P$	
Frequency	Annually, in the summer semester	

Workload	210 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
RES-WK-02	Power Electronics for Photo-voltaics and Wind Energy Plants	Prof. Dr.-Ing. St. Bernet
Contents and objectives	The module includes • structure and functionality of power semiconductor components that can be actively switched on and off • analysis of the functioning of self-guided circuits and ist core components for solar and wind energy plants (for example one phase and three phase 2L VSC, 3L NPC VSC) • design of the core components of the power electronic subsystem (output filter design) • modulation methods for controlling the power elec-tronic actuators • control and regulation procedures • safety and operational requirements. Qualification goals: It enables the selection and design of suitable circuits as well as the selection and design of the power semiconductor components for power electronic systems for operating solar generators for various applications. The students can verify the function of the system under consideration including the necessary control and / or regulation by using simulation tools.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week tutorials, 1 hour per week lab courses and self-study including a project of 40 hours.	
Prerequisites	Competences acquired in modules such as RES-H05 Power Electronics, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module examination consists of a project work PA and a written test K of 120 minutes.	
ECTS credit points and grades	7 ECTS credit points The module grade results from the grades of the examinations according to: M = 2/3 · K1 + 1/3 · PA	
Frequency	Annually, in the summer semester	
Workload	210 hours	

Duration	1 semester

Module number	Module name	Lecturer in charge
RES-WK-03	Solar Heat	Prof. Dr.-Ing. Clemens Felsmann
Contents and objectives	The module contains: Structure, function as well as dimensioning and operation of solar thermal systems for heat use with a special focus on large-scale systems for solar local and process heat supply as well as structure and function of solar thermal power plants including hybrid power plant processes for solar power generation. Qualification goals: 1. The students will have skills in design, interpretation and energy management evaluation of solar thermal Large plants 2. Master the basic principles of heat and electricity supply in solar thermal power plants.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorials, 1 hours per week lab courses and self-study.	
Prerequisites	Competences acquired in modules such as RES-G12 Fundamentals of Renewable Energy Systems, RES-G16 Technical Thermodynamics, RES-H09 Thermodynamics of Processes and RES-WK-01 Conversion of Solar Radiation, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module examination consists of two graded examinations and an ungraded laboratory course: With more than 20 participants, the examinations consist of a written exam PL1 for qualification goal 1 and PL2 for qualification goal 2, each lasting 120 minutes. In the case of up to 20 participants, the written exam is replaced by an oral exam as a group exam with up to 3 people in an amount of 20 minutes per person; if applicable, this will be announced to the registered students at the end of the registration period as is customary in the faculty.	
ECTS credit points and grades	7 ECTS credit points If the laboratory course was assessed as “passed”, the module grade results from the arithmetic mean of the grades of the other two examinations. If the laboratory internship was rated as “failed”, the module grade M is calculated according to:	

	M = 0.2 · PL1 + 0.2 · PL2 + 0.6 · 5
Frequency	Annually, in the winter semester
Workload	210 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
RES-WK-04	Geology and Exploration of Natural Energy Resources	apl. Prof. Dr. rer. nat. habil. St. Wagner TU Bergakademie Freiberg
Contents and objectives	Content: - Fluid mechanical properties of porous rocks and thermodynamics of pore fluids, - Basic laws of fluid mechanics, storage and Conveyor technology as well - Development of deposits of fluid raw materials (oil, natural gas, Water / geothermal energy) - Introduction to deep drilling technology (drilling rig, borehole construction, drilling, flushing, piping and cementation) Qualification goals: The students will master the classification of deposits. You are able to carry out a complex system analysis from the "upstream" (borehole) to the "downstream" area (heat exchanger / heat pump / power plant).	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week tutorials, and self-study.	
Prerequisites	Competences acquired in modules such as RES-G16 Technical Thermodynamics, RES-G17 Heat Exchange, RES-H09 Thermodynamics of Processes and RES-G18 Fluid Mechanics, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. With more than 20 participants, it consists of a written exam of 120 minutes. In the case of up to 20 participants, the written exam is replaced by an oral exam as a group exam with up to 3 people in an amount of 20 minutes per person; if applicable, this will be announced in writing to the registered students at the end of the registration period.	
ECTS credit points and grades	7 ECTS credit points The module grade results from the grade of the examination performance.	
Frequency	Annually, in the summer semester	
Workload	210 hours	

Duration	1 semester

Module number	Module name	Lecturer in charge
RES-WK-05	Heat Pumps, Organic Rankine Cycles (ORC) and Machinery	Prof. Dr.-Ing. U. Gampe
Contents and objectives	Content: • Areas of application for heat pumps and ORC processes (ORC = Organic Rankine Cycle) • Working fluids and their characterization (thermodynamic, chemical and physical properties) • Process control of heat pump and ORC processes • Machine and plant technology • Energy economic assessment Qualification goals: 1. The students will master the design and conception of heat pump and ORC processes. 2. You are able to dimension heat pumps and expansion machines according to the respective application areas and working fluids.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week tutorials, 1 hour per week lab courses, and self-study.	
Prerequisites	Competences acquired in modules such as RES-G17 Heat Exchange, RES-H10 Principles of Fluid Flow Machinery, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module examination consists of three examinations: With more than 20 participants, the examination achievements consist of a written exam PL1 for qualification goal 1 or PL2 for qualification goal 2 of 90 minutes each and a laboratory course P. For up to 20 participants, the written exam is completed by an oral exam as a group exam with up to 3 people replaced in the amount of 20 minutes per person; if applicable, this will be announced in writing to the registered students at the end of the registration period.	
ECTS credit points and grades	7 ECTS credit points The module grade results from the grades of the examinations according to: $M = 0.4 \cdot PL1 + 0.4 \cdot PL2 + 0.2 \cdot P$	
Frequency	Annually, in the winter semester	

Workload	210 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
RES-WK-06	Introduction to Numerical Solid and Fluid Mechanics	Prof. Dr.-Ing. habil. J. Fröhlich
Contents and objectives	Module content: - Introduction to methods for numerical calculation of solids and currents - Calculation of elastic bodies using the finite elements method and simulation of incompressible flows with finite volume methods - It includes basic knowledge of discretization procedures with which continuously given equations are converted into numerically solvable discrete systems and shows the possibilities as well as the limits of the procedures. Qualification goals: 1. The students will have the competence to use numerical methods (FEM). 2. You will know the elementary basics of flow simulation.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week tutorials, 1 hour per week lab courses, and self-study.	
Prerequisites	Competences acquired in modules such as RES-G15 Fundamentals of Kinematics und Kinetics and RES-G18 Fluid Mechanics, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of two written exams of PL1 120 minutes and PL2 90 minutes. If there are up to 20 participants, the written exam is replaced by an oral exam as a group exam with up to 3 people in an amount of 20 minutes per person; if applicable, this will be announced to the registered students at the end of the registration period as is customary in the faculty.	
ECTS credit points and grades	7 ECTS credit points The module grade consists to 2/3 of the grade for the exam of 120 min. and to 1/3 of the grade for the exam of 90 min.	
Frequency	annually, in every winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-WK-07	Lightweight Components of Wind Turbines	Prof. Dr.-Ing. M. Gude
Contents and objectives	The students learn how to adapt the structures of modern wind energy plants to stresses in an optimum way. Therefore they can implement the design rules for light weight structures and apply relevant multi-disciplinar knowledge in the areas of material and structural mechanics, constructuion as well as production technology. The module includes the basics for the lightweight construction of a wind turbine. - Basics of fibre composites (fibres, matrices, semi-finished products, characteristics etc.) - Development of modern lightweight structures in fiber composite intensive mixed construction for use in wind turbines - Design principles for lightweight structures made of fiber composite materials - Basic and advanced calculation methods as classic laminate theory for anosotropic composites and stability hypotheses - Holistic view of all relevant lightweight manufacturing technologies (new manufacturing processes) and their impact on the property profile Qualification goals: 1. The students master: - to select the fibre components that are appropriate for the material in light weight structures - to properly dimension basic light weight structures or materials 2. They are able to exploit the potential of lightweight design for the construction of wind turbines.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week tutorials, and self-study.	
Prerequisites	Competences acquired in modules such as RES-G15 Fundamentals of Kinematics and Kinetics and RES-G20 Design Engineering and Manufacturing Engineering, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of two written exams of 120 minutes and 90 minutes.	

ECTS credit points and grades	7 ECTS credit points. The module grade consists to 1/2 of the grade for the exam of 120 min. and to 1/2 of the grade for the exam of 90 min.
Frequency	annually, in the winter semester
Workload	210 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
RES-WK-08	Calculation of Wind Turbines	Prof. Dr.-Ing. M. Beitelschmidt
Contents and objectives	Content: - Dynamics of machines, plants and components and management of models and calculation methods - Overview of the theory of linear vibrations with a finite degree of freedom, their application to vibrational machine problems - Construction and calculation of foundations up to block foundation with the degree of freedom six - Bending vibrations, especially special processes for estimation of natural frequencies and waveforms - Drive dynamics of free and bound systems including special problems of rotor dynamics - Construction and design of drive trains in wind turbines with and without gear taking into account the requirements for onshore and offshore applications - Modeling of drives and gearboxes of the wind energy plants and associated design processes Qualification goals: 1. Students will have the ability to be engineering-practical to translate questions into machine-dynamic models, to solve simple cases by hand calculations and to check the results obtained by computer simulations with roll-over calculations. 2. The students will be able to design drive trains of wind turbines and to apply the necessary calculation methods for drives of wind energy plants.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week tutorials, and self-study.	
Prerequisites	Competences acquired in modules such as RES-G01 Introduction to Analysis and Algebra, RES-G02 Calculus for Functions with Several Variables RES-G14 Materials and Engineering Mechanics RES-G15 Fundamentals of Kinematcis and Kinetics RES-G20 Design Engineering and Manufacturing Engineering, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of two written exams of 120 minutes.	

ECTS credit points and grades	7 ECTS credit points The module grade consists to 1/2 of the grade for the exam of 120 min. and to 1/2 of the grade for the other exam of 120 min.
Frequency	annually, beginning in the winter semester
Workload	210 hours
Duration	2 semesters

Module number	Module name	Lecturer in charge
RES-WK-09	Electromagnetic Energy Conversion	Prof. Dr.-Ing. W. Hofmann
Contents and objectives	Content: 1. Design and calculation of electrical machines: parameters for optimum use of energy and general dimensions, windings and winding concepts, magnetic materials and magnetic circuit design, contacts: slip rings, brushes, commutator; determination and calculation of the machine parameters, loss calculation and efficiency, heating and cooling, concept development and optimization as well as laws of growth. 2. Transformers: power transformers; laws of growth; TK-number; core: structure, design, stationary mode and non-stationary mode; windings: structure and design of windings; insulation: terminology, insulation systems, insulation materials for transformers; design: core design, winding design, insulation design; clamping structures: terminology, principles, materials, design of core pressing elements, boiler design; sensors and control devices: oil monitoring, monitoring, EMC problems. Objectives: Having successfully completed this modules, the students have knowledge of the most important construction principles of electromagnetic power transformers and they are capable of designing, of calculating, of simulating with FEM and of rudimentally optimizing electrical machines and transformers.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical lab course, 20 hours project, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 02 04 Electrical Machines.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module assessment consists of an oral exam of 40 minutes (PL1) as individual exam and a lab course (PL2).	
ECTS credit points and grades	7 ECTS credit points can be earned. The module grade (M) is derived from the weighted average of the grades of the elements of assessment: M=(7PL1+3PL2)/10	
Frequency	Annually, in the summer semester	

Workload	210 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
RES-WK-10	Biomass Sources	Prof. Dr.-Ing. Beckmann
Contents and objectives	Content: - The emergence of various biomasses (wood, energy crops, agricultural residues, biogenic residues) - Deployment and preparation procedures - Characterization with regard to chemical, mechanical, caloric and reaction properties - Use strategies depending on the properties for the energetic and material use (cascade use) - Energetic evaluation of the process chains Qualification goals: 1. The students will master the procedures of the provision processing and processing of biomass types and can characterize relevant properties. 2. They will have the ability to energetic process chains evaluate.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorials, 1 hour per week lab courses, and self-study.	
Prerequisites	Competences acquired in modules such as RES-G16 Technical Thermodynamics, RES-G17 Heat Exchange, RES-G18 Fluid Mechanics, as well as RES-H01 Specifics of Renewable Energy Systems, RES-H09 Thermodynamics of Processes, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 120 minutes and an ungraded laboratory course.	
ECTS credit points and grades	7 ECTS credit points can be earned. If the lab course was assessed as “passed”, the module grade results from the grade of the written examination. If the lab course was rated “failed”, the module grade is calculated according to: $M = 0.4K + 0.6 \cdot 5$	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-WK-11	Biomass for Energy	Prof. Dr.-Ing. M. Beckmann
Contents and objectives	Content: - Fundamentals of reaction technology with regard to the conversion of gaseous, liquid and solid fuels and associated pollutant generation and degradation mechanisms, - Process control in the fermentation, pyrolysis, gasification and combustion of various biomasses as well as the basics for downstream synthesis processes (gas processing, BtL), - Essential apparatus and its use in the processes of energy process engineering. Qualification goals: 1. The students will master the basics of reaction kinetics. 2. They will be able to characterize fuels, choose suitable process controls and dimension equipment technology.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorials, 2 hours per week lab courses.	
Prerequisites	Competences acquired in modules such as RES-G03 Basics of Science, RES-G14 Materials and Engineering Mechanics, RES-G16 Techical Thermodynamics, RES-H09 Thermodynamics of Processes, RES-G18 Fluid Mechanics, RES-G17 Heat Exchange, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 150 minutes and an ungraded lab course.	
ECTS credit points and grades	7 ECTS credit points can be earned. If the lab course was assessed as “passed”, the module grade results from the grade of the written examination. If the lab course was rated “failed”, the module grade is calculated according to: $M = 0.4K + 0.6 \cdot 5$	
Frequency	annually, in the winter semester	
Workload	210 hours	

Duration	1 semester

Module number	Module name	Lecturer in charge
RES-WK-12	Fuel Cells	Prof. Dr. A. Michaelis
Contents and objectives	Content: Balancing of material and energy flow in energy conversion plants (esp. fuel cell systems), definition of applied variables and terms related to energy and reaction, design of reactors with heterogeneous catalysed reactions, thermodynamic analysis of fuel cell systems, fundamentals of electromechanical energy conversion in the fuel cell, types of fuel cells and their design and function, fuel cell stack structure and function, system components and structure of the fuel cell systems, processes of synthesis gas production and gas treatment, thermal and catalytic afterburning of anode exhaust gas, characterization of the electrochemical properties of cells and stacks, efficiency of different system variants and its dependence on the applied fuel, requirements for fuel cell systems for different fields of application, life cycle and degradation of fuel cells and systems, fundamentals of electrolysis and cogeneration with chemical syntheses, (power-to-gas and power-to-liquids), storage concepts for electrical energy from renewable sources and meaning of the fuel cell technology for future power supply systems. Qualification goals: After successfully completing this module, the students will have broad basic knowledge in the field of fuel cell systems and electrolysis. The students are able to balance the quantity of substances and the energy on systems for energy conversion and energy storage, to describe the functioning of the fuel cell systems and to name the potential areas of application, to explain the components of the fuel cell system and their functioning, to calculate the efficiency of the energy conversion in the fuel cell system. They know the fundamentals in order to design reactors for fuel cell systems.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week tutorials, and self-study.	
Prerequisites	Competencies acquired in modules such as RES-G03 Basics of Science, RES-G14 Materials and Engineering Mechanics, RES-G16 Technical Thermodynamics, RES-H09 Thermodynamics of Processes, RES-G18 Fluid Mechanics, RES-G17 Heat Exchange, or equivalent.	

Requirements for the award of ECTS credit points	The credit points are awarded when the module assessment is passed. With more than 20 participants, it consists of a written exam lasting 120 minutes. In the case of up to 20 participants, the written test is replaced by an oral exam as an individual exam of 30 minutes; if applicable, this will be announced to the registered students at the end of the registration period as is customary in the faculty.
ECTS credit points and grades	7 ECTS credit points can be earned. The module grade is the grade of the written exam.
Frequency	annually, in the winter semester
Workload	210 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
RES-WK-13	Electric Drives	Prof. Dr.-Ing. W. Hofmann
Contents and objectives	The module includes - Basics and dimensioning of electric drives: Introduction, motion processes, heating processes, applications of the equation of motion, work machines and motion converters, motor selection according to nominal operating modes; - Speed and torque control of drives: converter-fed DC drives, pulse converter-fed DC drives, speed control of asynchronous drives, slip-controlled asynchronous drives, frequency-controlled asynchronous drives, frequency-controlled synchronous drives, actuators; - Regulation of drives: Drive controls, regulated DC drives, regulated three-phase drives, field-oriented control, applications: machine tools, vehicles, mechatronics Qualification goals: After completing the module, the students will have the ability to make an application-oriented drive selection, to understand the operating behavior of electrical drives using replacement circuit diagrams, and to assess the control and regulating properties using suitable calculations and measurements.	
Modes of teaching and learning	3 hours per week lectures, 1 hour per week tutorials, 1 hour per week lab courses and self-study.	
Prerequisites	Competences acquired in modules such as RES-G09 Electrical Power Engineering, RES-H06 Electrical Machines, RES-H05 Power Electronics, or equivant.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam PL1 of 180 minutes and the lab course P.	
ECTS credit points and grades	7 ECTS credit points can be earned. The module grade is based on: $M = 0.7 \cdot PL1 + 0.3 \cdot P$	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-WK-21	Fundamentals of Energy Storage	Prof. Dr.-Ing. P. Schegner
Contents and objectives	Contents of the module are - thermal and mechanical energy storage, - compressed air storage systems as well as - electrical and electrochemical storage systems. Qualification goals: After completing the module, the students will understand the basic properties of the different energy storage systems and know criteria for their comparative evaluation. You can select and dimension the energy storage systems for various applications (e.g. short or long-term storage). In addition to the technical assessment, they are also familiar with the economic and ecological aspects of the storage systems.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week tutorials, and self-study.	
Prerequisites	Competencies acquired in modules such as RES-G09 Electrical Power Engineering, RES-H01 Specifics of Renewable Energy Systems, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are awarded when the module assessment is passed. The module examination consists of a written exam of 180 minutes. With up to 5 participants, the written exam is replaced by an oral exam as individual exam of 45 minutes.	
ECTS credit points and grades	7 ECTS credit points can be earned. The module grade is the grade of the exam.	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-WK-22	Dam Engineering and Hydroelectric Power Engineering	Prof. Dr.-Ing. J. Stamm
Contents and objectives	The module contains basic and special hydraulic aspects in planning, construction and operation for various types of dams. The hydraulic and functional optimization of the structure, the tightness and stable integration of the structure into the subsoil as well as the construction and operation of dams form a special focus. Students are thus able to weigh and assess water management, operational and ecological aspects. They have in-depth competences for constructive design and hydraulic dimensioning, for monitoring, for the renovation and modernization of old systems, especially river and dams. The students are thus able to assess the function of a storage facility comprehensively. Another focus is the energetic use of dams by means of hydropower plants. The students have an insight into energy economics terms and topics, renewable energies, turbine types and their characteristic diagram, run-of-river power plants, power plant chains or small hydropower plants and are able to assess ecological conflict points and measure plant parts and their profitability.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week tutorial, a project and self-study.	
Prerequisites	Competences acquired in modules such as RES-G12 Fundamentals of Renewable Energy Systems and RES-G18 Fluid Mechanics, or equivalant.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module examination consists of a written exam K1 (120 min) on dams, a written exam K2 (120 min) on hydro-power plants and an ungraded project work on hydropower plants of 30 hours.	
ECTS credit points and grades	7 ECTS credit points If the project work was rated as “passed”, the module grade is based on: $M = 0.5 \cdot K1 + 0.5 \cdot K2$ If the project work was rated as “failed”, the module grade is calculated according to: $M = 0.2 \cdot K1 + 0.2 \cdot K2 + 0.6 \cdot 5$	
Frequency	annually, beginning in the winter semester	

Workload	210 hours
Duration	2 semesters

Module number	Module name	Lecturer in charge
RES-WK-24	Chemical Thermodynamics	Prof. C. Breitkopf
Contents and objectives	Students will be able to develop thermal equations of state for distinguish and calculate ideal and real gases, as well as identify the uses of real gas equations. They learn to find the right thermodynamic technical vocabulary (state and process as well as 1st and 2nd law) for material conversion processes (phase transitions of pure substances, mixed phase formation, chemical reactions). Students will also be able to study material transformation processes with the help of the respective phase diagrams and describe the basic laws of thermodynamics. They know the characteristics of chemical thermodynamics fundamental equations and can calculate their temperature and pressure dependency. The students are familiar with energy and process relevant characteristics of mixtures and their characteristics turnarounds. Contents of the module are thermal equations of state for ideale and real gases (virial equations, van der Waals equation), State variables of mixtures (partial molar quantities), thermochemistry of material transformation processes (enthalpy of reactions, Hess's theorem, temperature and pressure dependence thermo-chemical state variables), General laws of equilibrium and non-equilibrium (fundamental equations, Gibbs and Helmholtz Energy, Chemical Potential) and applications to material conversion processes; Phase equilibria of pure substances (phase diagrams, vapor pressure, fusion pressure, sublimation pressure curves, Clausius-Clapeyron, classification of phase over-according to Ehrenfest), mixed-phase equilibria, specifically: Solvent equilibria (freeze-temperature low, boiling temperature increase, colligative properties) and their applications, solubility and distribution equilibrium weights (Henry coefficient, Nernst distribution factor) and their applications, vapor-liquid equilibria (Raoult's and Dalton's law, temperature and pressure composition, respectively (e.g. diagrams) and their applications as well as systems with liquid and solid phases (melt equilibria with complete dig and completely incomplete miscibility of solid phases, eutectics) and their applications (Fe-C diagram, latent storage cher); chemical equilibria (van-t Hoff's reaction isotherme, law of mass action, dealing with equilibrium constant, temperature and pressure dependence of the equilibrium weight constants). Basic thermodynamic properties; these are to be deepened in the practical lab course.	
Modes of teaching	2 hours per week lectures, 2 hours per week tutorial, practical	

and learning	lab course and self-study.
Prerequisites	Competences acquired in modules such as RES-G16 Technical Thermodynamics.
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module examination consists of a written exam of 120 minutes.
ECTS credit points and grades	7 ECTS credit points. The module grade is the grade of the examination.
Frequency	annually, in the wimmer semester
Workload	210 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
RES-WK-31	Network Integration, System Performance and Quality of Supply	Prof. Dr.-Ing. P. Schegner
Contents and objectives	The module contains different aspects of the quality of supply as voltage quality, supply reliability and relevant national and international standards. Further, it contains aspects of how electrical equipment is exposed to special stationary and transient operation processes. Qualification goals: The students will be able to evaluate the affects of consumer and generation systems on the voltage quality. The will know the methods to evaluate the supply reliabilty of the electric energy supply as well as calculation results. Further, they will be familiar with special stationbary and transient operation processes as well as their effects.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week tutorial, 1 hour per week lab courses, and self-study.	
Prerequisites	Competences acquired in modules such as RES-G06 Fundamentals of Electrical Engineering, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 150 minutes and a lab exam. With up to 5 participants, the written exam can be replaced by an oral exam as individual exam of 45 minutes.	
ECTS credit points and grades	7 ECTS credit points can be earned. The module grade is the weighted mean of the examinations: M = (3 PL1 + 2 PL2) / 5	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-WK-32	Heat Supply	Prof. Dr.-Ing. Clemens Felsmann
Contents and objectives	Content: - municipal and industrial district heating supply - heating technology and drinking water heating; heat distribution and heat use in buildings as well as combined heating and cooling systems. - technologies of heat supply, heat transfer within the networks and to the customer - network design, pressure maintenance, safety requirements - regulation and optimization of heating networks considering the heat storage - requirements concerning decentralised heat feeding, multifunctionality and integration of renewable energy sources into heat networks - central and decentralised heat and power and cooling processes Qualification goals: 1. The students will know the construction and the main components of central and decentralised systems of district heat supply. They will be able to plan, construct and operate these systems. They will know methods of optimizing such systems. 2. The students will know about the construction and main components of space heating and cooling as well as drinking water heating. They will be able to plan, construct and operate these systems. They will know methods of optimizing such systems.	
Modes of teaching and learning	4 hours per week lectures, 1 hours per week tutorial, and self-study.	
Prerequisites	Competences acquired in modules such as RES-G16 Technical Thermodynamics, RES-G17 Heat Exchange, RES-H09 Thermodynamics of Processes, RES-H10 Principles of Fluid Flow Machinery, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 180 minutes. With up to 20 participants, the written exam will be replaced by an oral exam as group exam with maximum 3 students and of 30 minutes per student.	

ECTS credit points and grades	7 ECTS credit points can be earned. The module grade is the grade of the assessment.
Frequency	annually, in the winter semester
Workload	210 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
RES-WK-33	Hydrogen Technologies	Prof. Dr.-Ing. habil. A. Hurtado
Contents and objectives	This module includes basic aspects about the current available technical and technological requirements of a hydrogen-based energy industry (generation, storage, transport, application). It also includes further development trends in this area as well as the general energy conditions for a hydrogen energy industry (efficiency, costs, price structures). The module also focuses on low-temperature, process and storage technologies as well as safety-related aspects. Qualification goals: 1. The students will master the casics of hydrogen technology and know the associated components for a hydrocarbon-based energy industry. 2. The students will know the basics of low-temperature and storage technology for the energy source hydrogen.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week tutorial and self-study.	
Prerequisites	Competencies acquired in modules such as RES-G16 Technical Thermodynamics, RES-H01 Specifics of Renewable Energy Systems, RES-H03 Introduction to Energy Economics and Management, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are awarded when the module assessment is passed. The module examination consists of two written examinations of 90 each.	
ECTS credit points and grades	7 ECTS credit points The module grade results from the grades of the examinations according to: $M = 0.5 \cdot K1 + 0.5 \cdot K2$	
Frequency	Annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-WK-41	Demand Response	Prof. Dr.-Ing. C. Felsmann
Contents and objectives	The module contains the characteristics of thermal and electric load curves as well as of the heating, cooling and electricity demand of buildings and insustrial processes. Dependencies between temporal load requirements and different influencing factors will be analysed. Qualifiaction goals: The students will be able to determine the energy demand and energy indicators by means of specific load curves of buildings and industrial processes taking into account the different supply structures and usage requirements. The will be familiar with the methods and potentials of the load management considerung selected storage technologies. They will know how to evaluate the energy efficiency during energy use.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week tutorial, and self-study.	
Prerequisites	Competences acquired in modules such as RES-G17 Heat Exchange, RES-G09 Electrical Power Engineering, RES-H10 Principles of Fluid Flow Machinery RES-H01 Specifics of Renewable Energy Systems, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 180 minutes. With up to 10 participants, the written exam will be replaced by an oral exam as individual exam of 45 minutes.	
ECTS credit points and grades	7 ECTS credit points can be earned. The module grade is the grade of the assessment.	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-WK-42	Project Managament	Prof. Dr.-Ing. habil. A. Hurtado
Contents and objectives	The modules contains the following fields which will be discussed by means of practical examples: - basic knowledge about dealing with project related management tasks - interaction between single aspects of project management - sustainability, innovation and change management - management of international projects - instruments and methods of technology assessment - legal framework Qualification goals: The students will be able to manage complex projects in the field of renewable energy systems considering technological, economical, ecological and social aspects. They will be able to work-oriented.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week seminar, a project, and self-study.	
Prerequisites	Competences acquired in modules such as RES-G16 Technical Thermodynamics, RES-H01 Specifics of Renewable Energy Systems, RES-H03 Introduction to Energy Economics and Management, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam (K) of 120 minutes and a project work (P) of 30 hours.	
ECTS credit points and grades	7 ECTS credit points The module grade results from the grades of the examinations according to: $M = 0{,}6 \cdot K + 0{,}4 \cdot P$	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
RES-WK-43	Process Simulation and Operation	Prof. Dr.-Ing. habil. L. Urbas
Contents and objectives	The module contains knowledge-based methods and algorithms for automated process evaluation, process diagnosis and process control. Qualification goals: The students will be able to plan, design, implement and operate complex knowledge-based close-to-process (partially)automated information processing systems. They will be able to combine and use such methods in systems theory and automation terms in order to create complex automation systems.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week tutorial, 2 hours per week project, and self-study.	
Prerequisites	Basic knowledge and skills in programming in a line-oriented language (C, Matlab or others).	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam (PL1) of 90 minutes, an oral exam (PL2) of 30 minutes, and a project work (PL3) of 30 hours.	
ECTS credit points and grades	7 ECTS credit points can be earned. The module grade is the weighted mean of the examinations according to: M = (PL1 + PL2 + PL3) / 3.	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
RES-WK-44	Controlled Power Systems	Prof. Dr.-Ing. W. Hofmann
Contents and objectives	Content: 1. Controlled energy systems: Definition of energy and performance, general control structures; synchronous generator: energy converters, modelling, regulation; network and isolated operation; asychronous generators: single andf double fed energy converters, modelling, regulation; network and isolated operation; exemplary regulations: steam power plant, hydropowerplant, wind power plant, pump storage plant; flywheel accumulators: flywheel, motor/generator, converter, magnetic bearings, construction, regulation; grid control: primary, secondary and tertiary regulation; power flow regualtors: contact based, line commulated, self commutated FACTS, regulating transformers, active filters; high voltage direct current transmission and 2. Electrical machine dynamics: Methods and types, dynamic behaviour of orthogonal windings – externally excited direct current machine, dynamic behaviour successive windings – transformers, torque determined from energy efficieny or field sizes, types of space vectors, transmission behaviour and dynamic operating status of induction machines, upper shafts analysis, harmonics analysis, zero sequence networks, wave processes and stress analysis. Objectives: The students will have knowledge of the design and the operating behaviour of electric energy transformers in power plants. They will understand the dynamic processes in electrical machines and networks, and they can design and optimize regulated plants.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical lab course, 1 project (20 hours), and self-study.	
Prerequisites	Competences acquired in modules such as RES-H06 Electrical Machines, RES-H07 Control of Continuous Time Processes, or equivalent.	

Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module assessment consists of an oral exam of 40 minutes (PL1) as individual exam and a lab course (PL2).
ECTS credit points and grades	7 ECTS credit points can be earned. The module grade (M) is the weighted average of the grades of the assessments: M= (7PL1+3PL2)/10
Frequency	annually, in the winter semester
Workload	210 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
RES-WK-45	Information and Communication Technologies	Prof. Dr.-Ing. F. Fitzek
Contents and objectives	The module contains two topics: (a) communication networks and (b) information and communication technology for Smart Grids. Topic (a) includes the principles of message sending in communication networks, the design of wire, wireless and optic communication networks as well as the communication protocols of the OSI layer model. Access methods, multiplexing techniques and up-to-date network technologies are taught. Topic (b) includes basics of network regulated systems with a focus on IoT solutions. The topic also includes the physical and MAC layers of leading IoT technologies, database management systems, data analysis, machine learning and network security. Qualification gaols: The students will learn the basic concepts that are needed in order to design and implemenet a network regulated system.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week tutorial, and self-study.	
Prerequisites	Competences acquired in modules such as RES-G04 Computer Science, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of two written exams of 150 minutes (K1) and 90 minutes (K2). With up to 15 participants, the written exams will be replaced by an oral exam as individual exam of 30 minutes each.	
ECTS credit points and grades	7 ECTS credit points can be earned. The module grade is derived from the grades of the examinations according to: $M = 2/3 \cdot K1 + 1/3 \cdot K2$	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-WK-46	Energy efficiency, Energy management, and Environmental law	Prof. Dr.-Ing. C. Felsmann
Contents and objectives	The module contains: - energy management, efficient energy usage by analysing requirement structures, load forecast, energy storage, and optimized operation of plants - basics of the legal working techniques taking into account environmental law, environmental constitutional law, and environmental administrative law; principles and control elements of environmental law; renewable energy systems; recycling economy protection law, water protection law, nature protection law, soil protection law. Qualification goals: 1. The students will know methodical approaches in order to increase efficieny and optimize the operation of energy systems. They will have detailed knowledge in the organization and technical realization of energy management measures. 2. The students will know methodical approaches in order to deal with the regulations in the field of environmental law. They are familiar with the basics of the environmental law and have basic knowledge in the legal interrelations within the environmental law. They can solve problems regarding environmental law on the basis of the applicable law.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week tutorial, and self-study.	
Prerequisites	Competences acquired in modules such as RES-G17 Heat Exchange, RES-H09 Thermodynamics of Processes, RES-H10 Principles of Fluid Flow Machinery RES-H02 Fundamentals of Electrical Power Systems, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 120 minutes (PL1) and a written exam of 90 minutes (PL2). With up to 10 participants, the written exam PL1 will be replaced by an oral exam as group exam with up to 3 students and 20 minutes per student.	
ECTS credit points and grades	7 ECTS credit points can be earned. The module grade is derived from the grades of the examinations according to:	

	M = 0,7 · PL1 + 0,3 · PL2
Frequency	annually, in the winter semester
Workload	210 hours
Duration	1 semester

Module descriptions
Main studies modules 5th-10th semester
(Complimental Modules)

Module number	Module name	Lecturer in charge
RES-WE-01	Particle Technology for Renewable Energy Systems	Prof. Dr.-Ing. habil. M. Stintz
Contents and objectives	The module contains the basics of particle characterization in suspensions, bulk solids and aerosols as well as in composite materials. Further, selected mechanic processes such as crushing, storing and dosing of bulk materials as well as processes for dedusting gas flows will be taught. Qualification goals: The students will be able to characterize disperse systems in different states. They will be able to create and optimize selected mechanic processes in order to change disperse systems.	
Modes of teaching and learning	3 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical lab course, and self-study.	
Prerequisites	none	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of two written exams of 90 minutes (K1) and 120 minutes (K2), and a practical lab course (Pr).	
ECTS credit points and grades	7 ECTS credit points can be earned. The module grade is derived from the grades of the examinations according to: $M = 0{,}2 \cdot K1 + 0{,}5 \cdot K2 + 0{,}3 \cdot Pr$	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-WE-02	Electromagnetic Compatibility	Prof. Dr. rer. nat. habil. H. G. Krauthäuser
Contents and objectives	The module contains topics and questions regarding electromagnetic compatibility of technical systems and regarding automated measurement procedures with a particular focus on measurement uncertainties. Qualification goals: The students will be able to deal with theorectical and practical questions regarding electromagnetic compatibility. The will know the legal EU frameworks and will be familiar with the most important standards. The students will be able to reveal possible couplings for unwanted effects of electromagnetic interference and take countermeasures. Further, the students will be able to plan complex measuring procedures and map them in programmes.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week practical lab course, and self-study.	
Prerequisites	none	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 120 minutes (PL1) and the practical lab exam. With up to 20 participants, the written exam PL1 will be replaced by an oral exam as individual exam of 40 minutes each.	
ECTS credit points and grades	7 ECTS credit points can be earned. The module grade is derived from the grades of the examinations according to: $M = 2/3 \cdot PL1 + 1/3 \cdot PL2$	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-WE-03	Protection and Control of Electrical Power Systems	Prof. Dr.-Ing. P. Schegner
Contents and objectives	The module contains the design and principle of operation of the protection and control technology in electrical power systems. Further, it contains essential criteria of selective protection technology and the algorithms used. Qualification goals: The students will be able to 1. evaluate criteria for identifying possible errors in electrical power systems in terms of suitability and accuracy. They will be able to design protection technology and to determine the necessary setting parameters. 2. interprete the interfaces between process and subsystems of secondary technology. They will be able to interprete different communication topologies and they will be familiar with the communication protocols used in switchboards.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week tutorial, 1 hour per week practical lab course, and self-study.	
Prerequisites	Competences acquired in modules such as RES-WK-31 Network Integration, System Performance and Quality of Supply, RES-H02 Fundamentals of Electrical Power Systems, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of two written exams (of PL1 120 minutes and of PL2 90 minutes) and a PL3 lab course. With up to 5 registered students the written exams can be replaced by two oral exams as individual exams of 45 and 30 minutes. The lab course has to be completed successfully.	
ECTS credit points and grades	7 ECTS credit points can be earned. The grade is derived from the weighted average of the grades of the examinations according to: M = (2 PL1 + 1 PL2 + 2PL3) / 5.	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-WE-04	Planning of Electrical Power Systems	Prof. Dr.-Ing. P. Schegner
Contents and objectives	Contents: - mathematical methods for calculating the stress of individual equipment within electrical power systems and - the principles of planning electro technical installations and distribution networks. Intended learning outcome: The students are able to calculate and assess holistically, steady and transient stress. They have mastered all important procedures and methods to dimension respectively select the equipment with regard to their voltage and current stresses and other criteria. The students know the basic standards for the planning.	
Modes of teaching and learning	4 hours per week lectures, 3 hours per week tutorials, and self-study	
Prerequisites	Competences acquired in modules such as RES-H02 Fundamentals of Electrical Power Systems, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of a written exam of 120 minutes (PL1) and two written exams of 90 minutes (PL2 and PL3). With up to 5 registered students the written exams can be replaced by an oral exam as individual exam of 45 minutes (PL1) and two oral exams as individual exams of 30 minutes (PL2 and PL3).	
ECTS credit points and grades	7 ECTS credit points can be earned. The grade is derived from the weighted average of the grades of the examinations according to: M = (4 PL1 + 3 PL2 +3 PL3) / 10	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-WE-05	High Voltage Engineering	PD Dr.-Ing. habil. S. Schlegel
Contents and objectives	The module contains selected topics from - High voltage engineering - Insulation technology - Lightning protection Qualification: After successful completion of the module, the students will be able to evaluate the function, design and rating of electrical equipment. Furthermore the students will learn simplified methods to dimension and test electrical equipment.	
Modes of teaching and learning	5 hours per week lectures, 1 hour per week practical lab course, and self-study.	
Prerequisites	Competences acquired in modules such as RES-H04 High Voltage and High Current Engineering, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of an oral exam as individual exam of 30 minutes (PL1) and a lab course (PL2).	
ECTS credit points and grades	7 ECTS credit points can be earned. The grade is derived from the weighted average of the grades of the examinations according to: M = (7 PL1 + 3 PL2) / 10	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-WE-06	Stress of Electrical Equipment	PD Dr.-Ing. habil. S. Schlegel
Contents and objectives	The module contains - Basics of the design and operational mode of electrical equipment with high current load in electrical power engineering Qualification: By completing the module successfully, the students will be able to rate, evaluate and test components of systems with high current load. They will be enabled to do scientific research on the subject.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week practical lab, 1 project, and self-study.	
Prerequisites	Competences acquired in modules such as RES-H04 High Voltage and High Current Engineering, RES-WE-05 High Voltage Engineering, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of an oral exam as individual exam of 30 minutes (PL1), one project (PL2), and a practical lab course (PL3).	
ECTS credit points and grades	7 ECTS credit points can be earned. The grade is derived from the weighted average of the grades of the examinations according to: M = (2 PL1 + PL2 + PL3) / 4.	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-WE-07	Microprocessor Control in Power Electronics	Prof. Dr.-Ing. St. Bernet
Contents and objectives	The module contains: - the design and function of common power electronic topologies for energy and drive applications, - analyses of the characteristics and simplification of the topologies for the modelling in order to design the control, - common modulation methods for the generation of the control signals and possible implementations on digital control platforms, - common feed-forward and feed-back control algorithms and issues of the implementation on digital control platforms, - programming of the control of a voltage source converter in order to operate an induction motor. Objectives: The students are capable of implementing controllers on a digital control platform by using a high-level programming language. They are capable of understanding the structure and function of a digital control platform, and of rating the main characteristics of a digital control platform in relation to the application, and of evaluating the pros and cons of different solutions.	
Modes of teaching and learning	2 hours per week lectures, 1 hour per week tutorial, 2 hours per week practical lab course, and self-study.	
Prerequisites	Competences acquired in modules such as RES-H05 Power Electronics, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module assessment consists of an oral exam (PL1) of 20 minutes as group exam with up to 3 students and of 20 minutes per student, and a project of 3 weeks (PL2).	
ECTS credit points and grades	7 ECTS credit points can be earned. The grade is derived from the weighted average of the grades of the examinations according to: M = (PL1 + 3 PL2) / 4.	
Frequency	annually, in the summer semester	
Workload	210 hours	

Duration	1 semester

Module number	Module name	Lecturer in charge
RES-WE-09	Design of Power Electronic Systems	Prof. Dr.-Ing. St. Bernet
Contents and objectives	The module contains - the function of basic topologies (DC/DC converter, voltage source converter) in order to derive a mathematical model, - modelling of common power semiconductor switches, - calculation of the system variables at a stationary operating regime, - design of the passive components of power electronic systems, - design of common feed-forward and feed-back control algorithms, - verification of the function with simulation tools. Objectives: The students are capable of using basic methods to simplify a power electronic system and its components in order to derive a mathematical model. The students are capable of calculating the system variables with the mathematical model, and of designing the components and the control including observers.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week tutorials, 40 hours project, and self-study.	
Prerequisites	Competences acquired in modules such as RES-H05 Power Electronics, RES-WK-02 Power Electronics for Photovoltaics and Wind Energy Plants, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module assessment consists of an oral exam of 40 minutes as individual exam (PL1) and a project PL2.	
ECTS credit points and grades	7 ECTS credit points can be earned. The grade is derived from the mean of the grades of the examinations according to: M = (PL1 + PL2) / 2.	
Frequency	annually, in the winter semester	

Workload	210 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
RES-WE-10	Solar Cells Fabrication Technologies	Prof. Dr. rer. nat. J.W. Bartha
Contents and objectives	The module contains: - The technologies of microelectronics that are used to manufacture all types of solar cells. - The structure of the various solar cells resulting from the necessities of physical efficiency and technological possibilities. Qualification goal: The students will be able to - apply processes of thin film technology - differentiate the different types of solar types and their manufacturing technology - characterize failure mechanisms of components	
Modes of teaching and learning	6 hours per week lectures, and self-study.	
Prerequisites	Competences acquired in modules such as RES-H08 Measurement and Sensor Techniques, RES-H09 Thermodynamics of Processes and, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of an oral exam as individual exam of 30 minutes.	
ECTS credit points and grades	7 ECTS credit points can be earned. The module grade is the grade of the oral exam.	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-WE-11	Autonomous Microsystems	Dr.-Ing. habil. U. Marschner
Contents and objectives	The module contains: - The principles and constructive solutions of autonomous microsystems from a very wide range of applications. - The physical principles of sensors from a wide range of applications. - The basics of the materials used in microsystem technology. Qualification goal: The students will be able to develop autonomous systems based on knowledge of the basic material properties and the resulting sensor properties.	
Modes of teaching and learning	6 hours per week lectures, and self-study.	
Prerequisites	Competences acquired in modules such as RES-H08 Measurement and Sensor Techniques, RES-G14 Materials and Engineering Mechanics, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of two oral exams as individual exams of 15 minutes each and a written exam of 90 minutes.	
ECTS credit points and grades	7 ECTS credit points can be earned. The module grade is derived from the arithmetic mean of the 3 exams.	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
RES-WE-13	Selected Topics of Electrical Power Engineering	Head of specialization area Electrical Power Engineering
Contents and objectives	Contents of the module are current topics and questions of the electrical power engineering. Outcomes: After successful completion of the module, the students can deal with current and relevant and research-active areas of electrical power engineering. They can question and crosslink the knowledge acquired using new methodological approaches and contents.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week tutorials, and self-study	
Prerequisites	Competences acquired in modules such as RES-G09 Electrical Power Engineering, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of an oral exam as individual exam of 40 minutes.	
ECTS credit points and grades	7 ECTS credit points can be earned. The module grade is the grade of the oral exam.	
Frequency	annually, beginning in the summer semester	
Workload	210 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
RES-WE-14	CommunicationTechnology for Thermal and Electrical Power Engineering	PD Dr.-Ing. habil. J. Seifert
Contents and objectives	Contents of the module are the different methods of data transmission with a special focus on the sector coupling in energy technology. Starting with the requirements of the different energy markets in regard to the provision of data, the status quo of digitization is presented. In terms of content, current applications such as Smart Home Systems, virtual power plants and intelligent measuring systems is discussed. In addition to the technical basics also communication protocols for energy management (i. e. IEC 60780-5-104) and the respective specific system architecture (areas: provision/ storage/ distribution/ application) are taught. The teaching program includes all energetic areas (i.e. electrical energy technology, gas technology and heating technology). Another teaching focus is the structured preparation and analysis of forecasting and measurement data. In this regard, the teaching program includes simple evaluation algorithms (monitoring) up to complex optimization strategies. Another focus of the module is the teaching of modern, complex analysis methods. This includes the application of existing simulation programs, the generation of input parameters as well as the evaluation of the results. Further, analysis methods in the field of hardware in the loop and human in the loop methods are taught. Objectives: The students will know the methodology for the systemic design and optimization of digital infrastructures with a special focus on energy technology. Qualifications regarding digital infrastructure in all areas of energy technology (provision/ distribution/ application) as well as gas, heating and electricity sectors are provided. Further, the students will learn different methods of data collection and data evaluation for energy technical systems as well as the optimized control of decentralized energy systems.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorials, and self-study	
Prerequisites	Competences acquired in modules such as RES-G16 Technical Thermodynamics, RES-G09 Electrical Power Engineering, or equivalent.	

Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 180 minutes.
ECTS credit points and grades	7 ECTS credit points can be earned. The module grade is the grade of the written exam.
Frequency	annually, in the winter semester
Workload	210 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
RES-WE-15	Innovative Applications of Energy Storage Systems	Prof. Dr.-Ing. T. Bocklisch
Contents and objectives	The contents of the module contain methods and system concepts for storage demand analysis, storage integration and storage coupling in sustainable energy supply structures based on a high proportion of renewable energies between the sectors electricity, heat, transport and chemical raw materials. Contents of the module are basic principles, design and operational management procedures for hybrid systems and hybrid energy storage systems as well as typical fields of application (amongst others regenerative combination power plants, district storage concepts, self-sufficient energy supply systems as well as hybrid electricity, heat and gas storage in the industry). Furthermore, the innovation potentials of different energy storage technologies in regard to the further development of storage and conversion components (i. e. operating principles, design, materials used), the methods applied (i. e. for periphery control circuits) and the system technology (i. e. energetic/ information technology coupling structures, system analytical approaches). Objectives: The students will know advanced functional principles of electrical, mechanical, electrochemical and thermal energy storage and can choose correctly suitable energy storage technologies in combination with other flexibilization technologies for different fields of application. The students will know the importance of cross-sectoral energy use, and basic principles, coupling methods as well as dimensioning and operational management procedures for simple and hybrid energy storage systems in stationary, mobile and portable applications. They will know the innovation potential of the individual energy storage technologies in regard to the further development of storage and transformation components, the methods used for subordinate control and application-oriented operational management as well as the system engineering energy supply and coupling structures.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week tutorials, and self-study	
Prerequisites	Competences acquired in modules such as RES-WK-21 Fundamentals of Energy Storage, or equivalent.	
Requirements for the award of ECTS	The credit points are earned if the module assessment is	

credit points	passed. The module assessment consists of a written exam of 180 minutes. With up to 20 students the written exam will be replaced by an oral exam as group exam with up to 3 students and of 30 minutes per student.
ECTS credit points and grades	7 ECTS credit points can be earned. The module grade is the grade of the exam.
Frequency	annually, in the winter semester
Workload	210 hours
Duration	1 semester

Module number	**Module name**	**Lecturer in charge**
RES-WE-16	Experimental High Voltage Engineering	PD Dr.-Ing. habil. S. Schlegel
Contents and	The module contains	

objectives	- High voltage test technique - Measurement technique - Scientific methods for planning experiments and their statistical evaluation. Qualification: After successful completion of the module, the students will be able to plan and perform scientific experiments as well as to evaluate them statistically. The students will gain HV-related and methodical knowledge for scientific research on the subject.
Modes of teaching and learning	4 hours per week lectures, 2 hours per week practical lab courses, and self-study
Prerequisites	Competences acquired in modules such as RES-H04 High Voltage and High Current Engineering, RES-WE-05 Specialization High Voltage Engineering, or equivalent.
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of a lab course and an individual oral as individual exam of 30 minutes.
ECTS credit points and grades	7 ECTS credit points can be earned. The grade for this module is determined by the weighted average of the lab course and the oral exam. The oral exam is weighted as 70% of the module grade and the lab course as 30%.
Frequency	annually, in the winter semester
Workload	210 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
RES-WE-17	Optical Process Measurement	Prof. Dr.-Ing. J. Czarske
Contents and objectives	The content of the module includes the basic principles, the theoretical treatment and the practical implementation of optical measuring systems. This refers to mechatronic laser sensors, laser measurement systems for fluid technology, project work on optical process measurement technology. Qualification: The students will be able to implement optical measuring systems and use them to measure interesting physical quantities.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per project, and self-study	
Prerequisites	Competences acquired in modules such as RES-G03 Basics of Science RES-H08 Measurement and Sensor Techniques, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of an oral exam as individual exam of 30 minutes (PL1) and a semester project work of 60 hours (PL2).	
ECTS credit points and grades	7 ECTS credit points can be earned. The grade for this module is determined by the weighted mean of the two exams according to: M = (5*PL1 + 2*PL2) / 7.	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	2 semesters	