Number of module: 9	Module: Energy Conversion and Distribution
Coordinator of module	**Prof. Dr. A. Gregorzewski**
Lecturer	**Prof. Dr. A. Gregorzewski, Prof. Dr. M. Siegers, N.N.**
Period	1. and 2. semester
Credits	10 CP
Workload	On campus program: 128 h, self study: 172 h.
Status	optional
Prerequisites	Thermodynamics and Heat Transfer, Electrical Engineering (fundamentals)
Max. number of participants	25
Language	German / English

Skills to be acquired / Learning objectives

Subject based and methodical skills

The students are able to

• assess the manifold usage of thermal energy for the purpose of seawater desalination, refrigeration, power production etc., to understand the technical realization of these processes, to calculate the effort for transport, storage and support, to rate the value of different heat sources with respect to the second law of thermodynamics and to perform rough design calculation for different plant configurations and process combinations.

• assess the range and the possibilities of application of the different fuel cell types. The students are familiar with the technology of the fuel cells and are able to see the advantages of individual fuel cell types as well as of the critical points during the development and the implementation of various fuel cell types.

• to classify the technologies of electrical power generation, to understand and appraise the characteristics of electro-mechanic generators and electronic power devices, to deal with the components of the electrical grid and the technical requirements of power feed in, in order to plan renewable energy systems and to communicate with technical specialists in power engineering.

Personal and social skills

The students are able to apply and combine basic knowledge from bachelor courses on more complex situations, independent and within a team.

Contents

Process Heat (Gregorzewski)

- economical heat transport and heat storage
- heat recovery for warm water, hot water and steam production
- power production from waste heat and renewable heat sources
- combined heat and power production (CHP), part load behaviour
- pinch-point-analysis, exergy analysis, entropy analysis
- gain output from heat pumps and heat transformers
- heat recovery and refrigeration with thermal and mechanical vapour compression
- thermal seawater desalination and absorption cooling

Fuel Cells (Siegers)

- Introduction
- Fundamentals of a Fuel Cell

- Thermodynamics
- Efficiency
- Voltage-Current-Characteristics
- Types of Fuel Cell Systems
    - Classification of Fuel Cell Systems
    - Alkaline Fuel Cell (AFC)
    - Proton Exchange Membrane Fuel Cell (PEMFC)
    - Phosphoric Acid Fuel Cell (PAFC)
    - Molten Carbonate Fuel Cell (MCFC)
    - Solid Oxide Fuel Cell (SOFC)

Advanced Electrical Engineering (NN)

- Single phase and three phase alternating current
- Synchronous ans asynchronus generatours
- Transdormers
- Electricity grid and distribution
- Fundamental circuits of power electronics
- Frequency converters
- Grid connection and feed in

Related courses

Process Heat (3 CP), Fuel Cells (3 CP), Advanced Electrical Engineering (2 CP), Specialisation (2 CP)

Teaching skills	lectures (beamer, overhead-projector, black board) with integrated exercises and case studies
Exam	graded / non-graded performance tests on demand
Literature/Teaching aids	**Process Heat** J. Karl, Dezentrale Energiesysteme, Oldenbourg Verlag München Wien M. Mohr, P. Svoboda, H. Unger, Praxis Solarthermischer Kraftwerke, Springer Verlag, Heidelberg work sheets, exemplary calculations and generalized examples ***Fuel Cells*** Larminie, Dicks, Fuel Cell Systems Explained, Wiley Kurzweil, Brennstoffzellentechnik, Vieweg Verlag Kordesch, Simader, Fuel Cells and Their Applications, VCH-Verlag ***Advanced Electrical Engineering*** l. Freris, D. Infield: Renewable Energy in Power Systems, Wiley, Chichester 2008 V. Quaschning: Understanding renewable energy systems, Earthscan, London, 2007 L.L. Grigsby: The Electric Power Engineering Handbook (Electrical Engineering Handbook), CRC Press Inc (September 2000) J. Schlabach, K.-H. Rofalski: Power System Engineering: Planning, Design, and Operation of Power Systems and Equipment, Wiley-Vch 2008