Course syllabus

Vätgas, batterier och bränsleceller
Hydrogen, Batteries and Fuel Cells

MVKP25, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED M
Date of Decision: 2023-04-11

General Information

Elective Compulsory for: MHET1
Elective for: E4-em, K4, M4, W4-es
Language of instruction: The course will be given in English

Aim

The course aims to provide the students with knowledge and understanding concerning hydrogen as an energy carrier and how to produce and store it. In addition, description, applications and analysis of electrochemical devices like batteries, fuel cells and electrolyzers are presented. The basic mechanisms of momentum, heat, mass, charge (ion and current) transport phenomena are analyzed and introduction to modeling with focus on thermal management is presented. The students should reach ability to understand and apply the theory on engineering problems.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- describe methods for production and storage of hydrogen especially based on renewable energy resources like solar and wind power
- explain the basic electrochemical conversion processes
- understand the principles and function of various batteries
- explain the relation between material properties and the performance of a battery, especially lithium-ion battery
- describe usage and engineering aspects of batteries in vehicles
- understand engineering opportunities and applications of batteries

- explain the principles of various fuel cells, focus on PEMFC and SOFC
- understand under what conditions analytical or empirical methods are applicable
- understand the basic governing equations and methods for modeling, especially thermal management of batteries and fuel cells
- set up models for estimation of performance of electrochemical devices

Competences and skills
For a passing grade the student must

- analyze different transport phenomena and electrochemical processes in batteries and fuel cells.
- describe methods of hydrogen production and storage
- describe opportunities for batteries and fuel cells in vehicles
- critically review methods for analysis of performance of electrochemical devices and thermal management

Judgement and approach
For a passing grade the student must

- participate in discussions and judgement of relevant problems related to electrochemical conversion and devices
- present analysis and synthesis of basic phenomena and governing equations for batteries and fuel cells both in a written way and orally

Contents

The course covers hydrogen as an energy carrier and how to produce and store it. The role of hydrogen in future energy systems is discussed. Electrochemical conversion in batteries and fuel cells is described and analyzed. All major transport processes (of momentum, heat, mass, ion and current (charge)) and thermal management issues are presented. System integration is described. Properties and characteristics of energy relevant materials and their role in electrochemical devices are treated. Relevance for energy systems and the transportation sector is discussed. Various engineering problems are presented.

Lectures, tutorial sessions, project work and homeworks are included.

Guest lecturers from industries and universities.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: A written exam at the end of the course. Compulsory project work and homeworks.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Admission

Admission requirements:

- FAFA35 Physics - Thermodynamics and Atomic Physics or KETF01 Transport Phenomena, Basic Course or MMVF01 Thermodynamics and Fluid Mechanics or VVRF10 Fluid Mechanics
- FAFA35 Physics - Thermodynamics and Atomic Physics or KFKA05 Molecular Driving Forces 1: Thermodynamics or KFKA10 Thermodynamics and Surface Chemistry or MMVF01 Thermodynamics and Fluid Mechanics

Assumed prior knowledge: Thermodynamics, Fluid Mechanics, Heat Transfer.
The number of participants is limited to: No
The course overlaps following course/s: MVKF25, MVK160

Reading list

- Berg, H.: Batteries for Electric Vehicles. Cambridge Univ. Press, 2015.
- Bengt Sundén: Hydrogen, Batteries and Fuel Cells. Academic Press-Elsevier, 2019, ISBN: 978-0-12-816950-6.

Contact and other information

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