University *of Ljubljana*
Faculty *of Mechanical Engineering*

Electromobility 5 ECTS

Lecturer: **T. Katrašnik**

Lectures: 30h | Tutorials: 2h | Labs: 28h | Project: 0h | Lang. :

Objectives

- Understand the theoretical foundations in the field of electromobility and propulsion systems of electrified vehicle.
- Understanding the role and needs of electromobility in sector coupling paradigm.
- Understand processes and stressors in relevant components of electrified vehicle propulsion systems.
- To know and to understand interactions in interdependencies of different components in propulsion systems of electrified vehicle.
- Understand modelling approaches for simulating components and systems of electrified powertrains.
- Understand development and design approaches of more efficient and environmentally friendly electrified vehicle propulsion systems for the intended use of the vehicle.

Programme

The course provides a systematic multi-scale insight in Electromobility and its role and needs within the sector coupling paradigm. In the course, we initially explain basic principles of electrified powertrains (hybrid, plug-in hybrids, battery electric, fuel cell hybrid powertrains) and position electromobility in various conversion paths of energy vectors as well as analyse corresponding energy conversion efficiencies. We continue on a lower scale with insightful engineering level explanation of electrochemistry, providing basis for profoundly studying process in batteries, fuel cells and supercapacitors. Holistic insight comprises intertwined transport, electrochemical, degradation and heat generation as well as heat transfer phenomena in batteries and fuel cells. These topics are upgraded with transfer of this knowledge to mechanistically based simulation models. The course also covers electric machines by addressing basic electromagnetics in electric machines, their classification and designs including advantages and disadvantages of different types of electric machines, thermoregulation of electric machines and basics of inverters and control of electric machines. Acquired knowledge on the component level is upscaled to provide basis for advanced performance analyses and topological, technological as well as sizing optimisation of different topologies of electrified powertrains with respect to their intended use.

Prerequisites

Meeting the enrolment conditions for the Master's study programme of Mechanical Engineering - Research and Development program or equivalent.

Learning outcomes

After attending this course, the student will:

- Have in-depth theoretical, methodological and analytical knowledge with elements of research, which is the basis for scientific and professional work in the development, design and diagnostics of electrified vehicle propulsion systems.
- Independently use the acquired knowledge in the analysis, design and diagnostics of electrified vehicle propulsion systems.
- Be able to evaluate different topologies and processes in electrified vehicle propulsion systems.
- Be able to design environmentally friendly electrified vehicle propulsion systems with minimized negative environmental impact.
- Be able of independent self-driven education and research.

Assessment

1. Theory (lectures) – 50 %
2. Practical Coursework – 50 %

Literature

- Reiner Korthauer: Lithium-Ion Batteries Basics and Applications-Springer Berlin Heidelberg, 2018
- John Newman, Karen E. Thomas-Alyea: Electrochemical Systems, 3rd Edition, Wiley, 2004
- R O'hayre, SW Cha, W Colella, FB Prinz: Fuel cell fundamentals. John Wiley & Sons, 2016
- Mench, M.M. Fuel cell engines. Wiley, 2008
- Barbir, F: PEM fuel cells: theory and practice. London, Academic Press, 2013
- Guzzella L, Sciarretta A.: Vehicle Propulsion Systems - Introduction to Modeling and Optimization, 2nd ed., Springer, 2007, ISBN 978-3-540-74691-1