Course syllabus

Energiomvandlare för hållbara transporter
Energy Converters for Sustainable Transport

MVKN51, 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

Main field: Sustainable Energy Engineering.
Compulsory for: MHET1
Elective for: E4, M4-tt, W4-et
Language of instruction: The course will be given in English

Aim

The objectives of the course are, starting from the requirements of vehicle propulsion, to provide a thorough understanding of the different options we have for future vehicle powertrains, which have the potential for near-zero pollutant emissions and net zero greenhouse gas emissions.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to discuss the advantages as well as challenges of the different ways of powering transportation, be able to compare these, and link to the requirements of different markets and applications
- be able to explain the basic combustion and emission formation processes in spark ignition and compression ignition engines, deduce the challenges for combustion engines in a society that needs to reduce greenhouse gas

emissions and improve air quality; and explain the benefits and challenges when switching from fossil to renewable fuels
- be able to explain the basic energy conversion in battery electric powertrains, and their hybrid configurations with internal combustion engines
- be able to explain the basic energy conversion in fuel cells

Competences and skills
For a passing grade the student must

- be able to use characteristic parameters to analyze powertrain performance
- be able to select a powertrain and deduce its main features in terms of energy carrier, size, performance and emissions, for a given application
- be able to calculate the combustion stoichiometry using the exhaust gas composition from combustion of (renewable) fuels

Judgement and approach
For a passing grade the student must

- Critically assess and compare various options for sustainable transportation
- Determine the relevance and reliability of information on options for sustainable transportation, that might be used to support a conclusion or argument
- Include multiple viewpoints and criteria into an assessment of transportation options, appreciating the complexity of the issue
- Respectfully hear out opposing views and then objectively assess them
- Understand the limitations of his or her knowledge and understanding concerning sustainable transportation options

Contents

The course deals with powertrains for vehicles. The expectations are that in a sustainable society, transportation powertrains will be a mix between battery electric, fuel cell, combustion engine and hybrids thereof. The combustion engines would then be powered by renewable fuels produced using sustainable sources. First the coupling between the power requirement of a vehicle and the power produced by the powertrains is explained. Then, the main features of the different powertrains are given, with their pros and cons. Then, a more detailed discussion follows for each of the options.

A general description of the most common combustion engine types is given. The spark ignition and compression ignition principles are explained and the four stroke cycle is discussed. The combustion process in both the spark ignition and compression ignition engine is presented and ways to reduce pollutant emissions are explained. Challenges to the combustion engine fueled by fossil fuels are discussed after which the engine operation on renewable fuels is investigated together with their potential for lowering pollutant emissions and increasing engine efficiency. A short discussion on renewable fuel origins with opportunities and challenges is also scheduled.

The different configurations for hybrid powertrains are then presented and the criteria for choosing the optimum configurations depending on the application. Plug-in hybrids and range-extended hybrids are discussed. Advantages and challenges for battery electric drive and fuel cells are discussed, as well as expected future trends for the different transportation modes (passenger, heavy duty, marine, …).

The course contains lectures, seminars, exercises and assignments. Normally an industry representative will give an invited lecture.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Based on assignments and written examination. The assignments include a report on a virtual engine lab, and an assignment on critical thinking in sustainable transportation. The latter ends with student presentations, after submission of a list of references and a “one-pager”. The written examination includes theory and exercises. The final grade is a weighted average, with the weighting factors for lab report, presentation and final exam being 15%, 25% and 60% respectively. The final grade is either Fail or one of the passing grades 3, 4 or 5, which correspond to 50, 65 and 80% of the maximum number of points respectively.

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

Assumed prior knowledge: MMVF01 Thermodynamics and Fluid Mechanics OR KFKA10 Thermodynamics and Surface Chemistry OR FAFA35 Physics - Thermodynamics and Atomic Physics OR FMFF05 Thermodynamics with Applications or equivalent.
The number of participants is limited to: No
The course overlaps following course/s: MVKN50

Reading list

- Richard Stone: Introduction to combustion engines. Red Globe Press, 2012, ISBN: 9780230576636.
- Other litterature are not decided. The remaining litterature shall cover topics such as, fuel cells, battery electric vehicles, hybrids and renewable fuels.

Contact and other information

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