LUNDS UNIVERSITET
Lunds Tekniska Högskola

Course syllabus

Tillämpad kraftelektronik
Applied Power Electronics

EIEN60, 7,5 credits, A (Second Cycle)

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

General Information

Elective for: E4-em, F4, F4-es, M4-me, M4-tt
Language of instruction: The course will be given in English on demand

Aim

The purpose of the course is to provide good knowledge of the basics of power electronically controlled energy conversion in drive systems for e.g. electric vehicles, wind power generation, solar cell technology and mains connected batteries. The course builds the understanding of the control methods on detailed physical modeling of various energy converters. Generic models form the basis for method development and give the student tools to apply the methods also to energy converters other than those covered in the course. The course applies the methods to a selection of linear and rotating DC and AC machines, switched audio systems, DC / DC converters, active power filters, high voltage DC systems (HVDC), battery charging systems and power supply for electric vehicles (various types of chargers and electric roads).

Learning outcomes

Knowledge and understanding
For a passing grade the student must

be able to individually and in writing show

- understanding of how the most important physical properties of a given energy source (eg a regenerating electric drive system in a vehicle, a wind power generator or a photovoltaic system), energy converters (electric machine, loudspeaker) or energy storage (battery, electrolysis plant), are modelled with respect to power electronic energy

control,
- understanding of the function and properties of a selection of power electronic converters,
- understanding of how the physical properties according to paragraph 1 affect the choice of control methods as well as the modulation method for applicable power electronic converters.

Competences and skills
For a passing grade the student must

be able to individually and in writing

- model the most important physical properties of a given energy source (eg an electric drive system in generating vehicles, a wind power generator or a photovoltaic system), energy converters (electric machine, speakers) or energy storage (battery, electrolysis plant), with respect to power electronic energy control,
- describe the function and properties of a selection of power electronic converters,
- describe how the physical properties according to paragraph 1 affect the choice of control methods as well as the modulation method for applicable power electronic converters,
- in a simulation environment, implement generic models for energy converters with associated power electronic control systems,
- verify simulation results according to point 4 with power electronic control systems in a laboratory environment.

Judgement and approach
For a passing grade the student must

individually be able to

- assess the suitability of power electronic solutions for the physical and electromagnetic environmental impact and energy efficiency.

Contents

Lectures and arithmetic exercises
Sources and loads: Physical properties for electrical machines, cables, batteries etc. These properties are modeled from a power electronic control perspective, including parasitic components load currents and earth currents.

Power electronic converters: Summary of the characteristics of power electronic converters such as 1Q, 2Q and 3-phase 2-level converters.

Modulation and control: Carrier wave modulation, overmodulation, current control (sampled and with tolerance band), voltage control, torque control, speed control, optimization of efficiency, minimization of ripple.

Applications: Power and torque control of linear and rotating DC and AC machines including field weakening, optimization of efficiency and minimization of torque ripple. Active power filters and connection of batteries to the power grid as energy and power sources. Uninsulated and insulated DC / DC converters for adjusting voltage levels and

galvanic isolation of power systems. Vehicle power systems with many power electronic converters on the same DC link / battery, with respect to conducted electromagnetic compatibility (EMC).

Simulation tasks and laboratory work

- Active power filter
- DC / DC converter
- Electric machine (PMSM) in vehicle drive system.

These labs are prepared through simulation work, which is reported as a homework before the lab. After the laboratory, a report is written where simulations and measurements are compared.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Approved laborations and simulations that are reported continuously. Written exam (5 h) with both problem solving and theoretical questions.

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.

Parts
Code: 0122. **Name:** Power Electronics.
Credits: 5. **Grading scale:** TH. **Assessment:** Written exam **Contents:** Written exam
Code: 0222. **Name:** Laboratory and Simulation Exercises.
Credits: 2,5. **Grading scale:** UG. **Assessment:** Approved laboratory work and written reports. **Contents:** Approved laboratory work and written reports.

Admission

Assumed prior knowledge: ESSF01 Analogue Circuits, ESS030/ESSF20 Physics of Devices, ESSF15 Electrical Engineering (EE, WE), MIE012/EIEF35 Electrical Engineering, basic course (ME)or EITF90 Electromagnetics and Electronics (FE) and FRT010/FRTF05 Automatic Control, Basic Course.
The number of participants is limited to: No
The course overlaps following course/s: EIE041, EIE015, EIEN25

Reading list

- Alaküla M, Karlsson P: Power Electronics – Devices, Circuits, Control and Applications, IEA, LTH.

Contact and other information

Course coordinator: Professor Mats Alaküla, mats.alakula@iea.lth.se
Course homepage: https://www.lth.se/iea/utbildning/valfria-kurser-i-lund/tillaempad-kraftelektronik/
Further information: The course may not be combined with EIEN25 in the diploma.