LUNDS UNIVERSITET
Lunds Tekniska Högskola

Course syllabus

Kraftelektronik - komponenter och omvandlare
Power Electronics - Devices and Converters

EIEN55, 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, F4-fel, 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 knowledge about dimensioning and use of modern semiconductor components and related passive components in their applications in power electronic converters. The learning includes mechanical, electrical and thermal dimensioning of semiconductor components as well as inductors and capacitors, including modeling of their service life given a certain thermal and electrical cycling.

Furthermore, the course provides knowledge of principles for modulation, current and voltage control for different converter types.

The course provides an understanding of applications of power electronic converters such as switched power supplies, motor drive systems, solar cell converters, electric vehicle chargers etc. Furthermore, power grid applications such as "Unified Power Flow Controllers" (UPFC), active power filters, high voltage direct current (HVDC) etc. are studied.

Learning consists of lectures, arithmetic exercises, simulation work and lab work where simulations and laboratory work are closely linked.

Learning outcomes

Knowledge and understanding

For a passing grade the student must

be able to individually and in writing:

- describe the function and dimensioning properties of active and passive power electronic components
- analyze and understand power electronic circuits
- analyze modulation methods (carrier and tolerance bands) for power electronic converters

Competences and skills
For a passing grade the student must

individually be able to:

- make basic dimensioning of active and passive power electronic components
- design power electronic circuits of lower complexity
- propose modulation and control methods for power electronic circuits of lower complexity

Judgement and approach
For a passing grade the student must

individually be able to

- assess the suitability of power electronics solutions where non-power electronics alternatives exist with regard to the physical and electromagnetic environmental impact as well as energy efficiency.

Contents

Lectures and arithmetic exercises
Components: Diodes, transistors (BJT, IGBT, MOSFET), materials (silicon, silicon carbide), inductors, capacitors, sensors (current, voltage). Function, mechanical and thermal design, aging.

Circuits: Drive and protection circuits. Various bridges such as 1Q, 2Q and 3-phase 2- and multi-level converters. Parasitic components, load currents and earth currents.

Modulation and control: Carrier modulation, sampled current control, tolerance band control of current, voltage control.

Applications: Switching power supplies, motor drive systems for DC and AC motors, solar cell converters, electric vehicle chargers, "Unified Power Flow Controllers" (UPFC), active power filters, high voltage direct current (HVDC).

Simulation tasks and laboratory work

1. Primary switched power supplies.
2. 4-quadrant converter. Modulation with fixed and random frequency. Feedback current control.
3. 3-phase voltage generation for 230 V 3-phase.

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 - Components and Converters.
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) or MIE012, EIEF35 Electrical Engineering, basic course (ME) and FRT010, FRTF05 Automatic Control, Basic Course.
The number of participants is limited to: No
The course overlaps following course/s: EIEN25, EIE023, EIE015

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/kraftelektronik-komponenter-och-omvandlare/
Further information: The course may not be combined with ETEF10 Power Electronics