



LUNDS UNIVERSITET
Lunds Tekniska Högskola

Course syllabus

Komponentfysik Physics of Devices

ESSF20, 4,5 credits, G2 (First Cycle)

Valid for: 2023/24

Faculty: Faculty of Engineering, LTH

Decided by: PLED N

Date of Decision: 2023-04-17

General Information

Main field: Technology.

Compulsory for: E2

Elective for: D4

Language of instruction: The course will be given in Swedish

Aim

The course will give the student basic insights into what is hidden underneath the cover of the most common electronic devices, such as diodes and transistors. The course gives an introduction to how these devices are designed and how they work.

The function and performance are connected to the material properties and external parameters, such as voltages and temperature. The course links the functionality of a device in an electronic circuit (**Electronics and Analogue Circuits**) and the functionality of devices (**Device physics**)

The course is of importance as the development of electronic devices leads to new applications with better performance of the system they are incorporated into. An example is that we see faster computers and data communication, and increased functionality of mobile phones. Breakthroughs in materials science has led to the development of key devices, like the laser diode used in DVD-players and high speed transistors used in satellite communication.

Learning outcomes

Knowledge and understanding

For a passing grade the student must

- be able to describe the connection between the performance of a device and the properties of the materials it is made from.
- be able to explain the electrical and optical properties of a pn-junction.
- be able to explain how the bipolar transistor and the MOS-transistor work .
- be able to do calculations of currents and capacitances in semiconductors, diodes and transistors.

Competences and skills

For a passing grade the student must

- be able to analyse and evaluate experimental data.
- be able to apply models like the hybrid- π model, to model physical processes in devices.

Judgement and approach

For a passing grade the student must

- understand the connections between electrical and material properties.
- be able to use simple models, understand the link between the performance of a devices and its materials properties and geometry. And be able to modify the performance through modifying its design parameters.

Contents

The purpose of the course is to give an overview of how basic electronic devices work from a semiconductor physics view. The course introduces the fundamental physics behind devices through the introduction of the concept of band structure to define semiconductors, insulators and conductors. A cornerstone in device physics is the currents in semiconductors, caused by drift and diffusion of charge carriers. The course focuses on diodes, bipolar and MOS transistors. They are discussed in terms of potentials, current mechanisms, capacitances and materials properties.

The course also discusses how design parameters affect the properties in terms of gain and transition frequency, and how these can be modified by the design. The course also gives an introduction to the most commonly used opto-electronic devices, like light emitting diodes, laser diodes and photo diodes.

The course includes an overview of other types of common electronic devices that are available today and that might be available in the near future.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)

Assessment: The examination consists of a written exam, which is solved individually. The exam is composed of descriptive problems, as well as calculations. Each student is also required to hand in two assignments. In addition, the students must perform two laboratory exercises which are reported orally. Passed exam, passed hand-in assignments and passed laboratory exercises are required to pass the entire course. The grade is based on the written exam.

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: 0117. **Name:** Physics of Devices.

Credits: 2,5. **Grading scale:** TH. **Assessment:** Written exam.

Code: 0217. **Name:** Laboratory Work 1: Opto-electronic Devices.

Credits: 0,5. **Grading scale:** UG. **Assessment:** Oral presentation.

Code: 0317. **Name:** Laboratory Work 2: Pn-junctions.

Credits: 0,5. **Grading scale:** UG. **Assessment:** Oral presentation.

Code: 0417. **Name:** Assignment 1: Semiconductors.

Credits: 0,5. **Grading scale:** UG. **Assessment:** Hand-in assignment.

Code: 0517. **Name:** Assignment 2: Transistors.

Credits: 0,5. **Grading scale:** UG. **Assessment:** Hand-in assignment.

Admission

Assumed prior knowledge: EITA35 Electronics.

The number of participants is limited to: No

The course overlaps following course/s: ESS030, ETI240, FFF060, FFF090

Reading list

- Compendium (in Swedish).

Contact and other information

Course coordinator: Dan Hessman, Dan.Hessman@ff.lth.se

Course homepage: <https://canvas.education.lu.se>

Further information: Some elements may be taught and assessed in English. This includes a maximum of 1 hp, in the form of laboratory sessions or written assignments.