Reg No: FYAD19/20242

Faculty of Health, Science and Technology
Physics

Syllabus

Physical electronics

Course Code:	FYAD19
Course Title:	Physical electronics *Fysikalisk elektronik*
Credits:	7.5
Degree Level:	Master's level
Progressive Specialisation:	Second cycle, has only first-cycle course/s as entry requirements (A1N)

Major Field of Study:
FYA (Physics)
TKA (Engineering Physics)

Course Approval
The syllabus was approved by the Faculty of Health, Science and Technology 2024-01-31, and is valid from the Autumn semester 2024 at Karlstad University.

Prerequisites
45 ECTS credits in Physics, including Quantum Physics I, 7.5 ECTS credits, Electromagnetic Field Theory, 7.5 ECTS credits, and Solid State Physics, 7.5 ECTS credits, plus 30 ECTS credits in Mathematics, and upper secondary level English 6, or equivalent

Learning Outcomes
The aim of the course is for students to acquire knowledge of basic semiconductor and semiconductor devices physics and be able to use relevant theoretical models for calculating properties and performance of semiconductor materials and devices. Students are also expected to become familiar with handling modern electronic instruments for data collection and characterisation of semiconductors, semiconductor devices, and circuits.

Upon completion of the course, students should be able to:

- describe the crystal structure and electronic band structure of the most common semiconductor materials,
- give an account of the theoretical foundation of semiconductor physics and use the theory for calculating the electronic properties of semiconductor materials and charge transport,
- give an account of the physical foundation for the p-n junction, the function and transport characteristics of the p-n diode, the bipolar transistor, and the MOSFET transistor,
- describe metal-semiconductor junctions and semiconductor hetereojunctions and their application in electronic components,
- give an account of semiconductor-based solar cells, their equivalent circuit, and efficiency limitations,
- perform electronic characterisations of semiconductor components and use modern electronic measuring instruments, and
- give an account of the role of solar cells for energy systems and sustainable development.

Content
Theory:
- Survey of the crystal structure and electronic band structure of common semiconductors
- The properties of semiconductors: Distribution of electrons and holes, Fermi level, intrinsic and extrinsic semiconductors, doping, charge transport, conductivity, generation and recombination of electron-hole pairs
- The p-n junction, the p-n diode
- Metal-semiconductor junctions, Schottky diodes, ohmic contacts, semiconductor hetereojunctions
- The bipolar transistor
- The MOSFET transistor
- Semiconductor-based solar cells: Structure, function, manufacturing, types of defects, efficiency
- The role of solar cells for sustainable development, effects on energy systems, and changes over time
- Future advanced solar cell concepts

Laboratory work
- Hall effect
- Electrical characterisation of a number of semiconductor components, for example transistors

Reading List
See separate document.

Examination
Assessment is based on mandatory laboratory tasks, lab reports, and a written exam.

If students have a decision from Karlstad University entitling them to Targeted Study Support due to a documented disability, the examiner has the right to give such students an adapted examination or to examine them in a different manner.

Grades
One of the grades Distinction (VG), Pass (G), or Fail (U) is awarded in the examination of the course. For students in Engineering, one of the grades 5 (Pass with Distinction), 4 (Pass with Some Distinction), 3 (Pass), or U (Fail) is awarded in the examination of the course.

Quality Assurance
Follow-up relating to learning conditions and goal-fulfilment takes place both during and

upon completion of the course in order to ensure continuous improvement. Course evaluation is partly based on student views and experiences obtained in accordance with current regulations and partly on other data and documentation. Students will be informed of the result of the evaluation and of any measures to be taken.

Course Certificate
A course certificate will be provided upon request.

Additional information
The local regulations for studies at the Bachelor and Master levels at Karlstad University stipulate the obligations and rights of students and staff.