lelec2330

2021

Opto-electronic and power devices

5.00 credits	30.0 h + 30.0 h	Q1

Teacher(s)	Flandre Denis ;Francis Laurent (coordinator) ;
Language :	English
Place of the course	Louvain-la-Neuve
Prerequisites	Students should master the basic operating principles and constitutive equations of semiconductor-based devices such as diodes and transistors (as seen in LELEC1755 or equivalent)
Main themes	**Physical basis of electronics** (Part 1): • band structures, • semiconductors and metals, • phonons, • charge transport, • generation and recombination of carriers. **Applied electronic devices** (Part 2): • photosensors, • photovoltaic cells, • power/high-voltage and Zener diodes, MIS and MOS structures.
Learning outcomes	**At the end of this learning unit, the student is able to :** 1. Contribution to the learning outcomes of the ELEC programme see on https://uclouvain.be/prog-2020-fsa1ba-competences_et_acquis AA1.1, AA1.2 AA2.1, AA2.2, AA2.3, AA.2.4, AA2.5, AA2.6 AA4.2 AA5.1 1. Specific learning outcomes: **Physical basis of electronics** (Part 1): • Explain the concepts by means of mathematical models, graphical representations and one-dimensional numerical simulations, • Solve simple problems of semiconductor physics, e.g., Hall effect, illumination, thermopiles, … **Applied electronic devices** (Part 2): • Apply the physical mechanisms of part 1 at play in the operation of optoelectronic and power devices, • Determine the relevant mathematical models of their electrical operation and characteristics in the DC and low-frequency small-signal regimes, under dark or light conditions, versus temperature, • Compare and discuss these models versus the simulations and characteristics of real devices.
Evaluation methods	Students are evaluated individually on the basis of 1) a continuous evaluation through applied exercises during the semester, and 2) a written exam during the exam session, including a part of developments of theoretical concepts, and another part of problem solving. The latter part is of the same level than those of solved during the practical sessions of the course. The points acquired during the continuous evaluation are kept for all the sessions of the same academic year.
Teaching methods	The teaching is based on lectures and companion practical sessions. The comparison between theory, simulations and characteristics of real devices is important in the teaching approach to discuss and validate the model simplifications. In particular, simple structures will be thoroughly analysed in support of the content of the first part and, for the second part, advanced simulations helped by dedicated softwares will aim at validating model hypothesis and to visualise the results. These might also be used within the continuous evaluation. Literature search and provided references will support finding of actual devices and allow to highlight differences found between experimental (or real) and simulated properties.

Content	The lectures present in a dynamic way, based in good part on questions by the students, the concepts described above. The lectures and the practical sessions are both complementary with the written notes that present the concepts in more details. Specific exercises aim at applying the course concepts to solve problems related to semiconductor physics and basic electronics devices. **Part 1 – Physical basis of electronics** • chapter 1: energy bands of the perfect crystal • chapter 2: energy bands of metals • chapter 3: energy bands of semiconductors • chapter 4: lattice vibrations • chapter 5: transport equations • chapter 6: carriers generation and recombination mechanisms **Part 2 – Applied electronic devices** • chapter 7: advanced p-n junctions • chapter 8: advanced MOS capacitors • chapter 9: photodiodes • chapter 10: photovoltaics solar cells
Inline resources	Moodle
Bibliography	Notes and list of reference books available on Moodle (see above)
Faculty or entity in charge	ELEC

Programmes containing this learning unit (UE)

Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Electrical Engineering	ELEC2M	5		