GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Semiconductor Devices, PG_00047545		
Field of study	Automatic Control, Cybernetics and Robotics		
Date of commencement of studies	October 2021	Academic year of realisation of subject	2021/2022
Education level	first-cycle studies	Subject group	Obligatory subject group in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	2	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Microelectronic Systems -> Faculty of Electronics, Telecommunications and Informatics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Piotr Płotka	
	Teachers	dr hab. inż. Piotr Płotka	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	0.0	0.0	0.0	15

E-learning hours included: 0.0

Adresy na platformie eNauczanie:
Przyrządy Półprzewodnikowe 2022 - ACiR, IBM - sem. 2 - Moodle ID: 22596
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=22596

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	15	2.0	33.0	50

Subject objectives

Learning of operation principles of basic semiconductor devices and building skills in using the physical and electrical parameters, characteristics and equivalent circuits of the devices for designing electronic circuits.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_W02] Knows and understands, to an advanced extent, selected laws of physics and physical phenomena as well as methods and theories explaining the complex relationships between them, constituting the basic general knowledge in the field of technical sciences related to the field of study	knows and understands relations of electrical characteristics of commonly used semiconductor devices to the basic rules of semiconductor physics and of thermodynamics, eg. is able to predict an effect of potential barrier height at the device or an effect of electrical bias direction on the flow of electric current	[SW1] Assessment of factual knowledge
[K6_W03] Knows and understands, to an advanced extent, the construction and operating principles of components and systems related to the field of study, including theories, methods and complex relationships between them and selected specific issues - appropriate for the curriculum	knows and understands relations of electrical characteristics of widely used semiconductor devices to their basic, most often specified electrical and design parameters; is able to apply this knowledge and learned methods to find out a behavior of the devices in common applications	[SW1] Assessment of factual knowledge

<table>
<tr><td>Subject contents</td><td>Structure of a semiconductor crystal, a conduction band and a valence band. Concentration of electrons and holes in a semiconductor. Electron and hole transport mechanisms: drift-diffusion, tunneling, ballistic. A general idea of a transistor as a power amplifying element, with electric carrier flow regulated with a potential applied to a controlling electrode. A semiconductor diode as an element with a diffusion type injection of electric carriers over a built-in potential barrier - ideal static characteristic. Semiconductor diode - junction and diffusion capacitancies, breakdown, temperature effects, equivalent circuits - small-signal and charge-type, basic types and applications of diodes. MOS transistor as a device with a charge of carriers concentrated in one plane, and controlled with a gate-source potential - a simple charge-type model for deriving and understanding of IV curves. MOS transistor - a threshold voltage, capacitancies related to a transistor structure, temperature effects. Types of MOS transistors. MOS transistor - basic application circuits. Small- and large-signal equivalent circuits. A band of amplified frequencies and switching times for a pulse operation. Bipolar transistor as a device with a current limited with a diffusion-type injection of carriers over an emitter-base potential-barrier and with transport rate in the base. IV curves. Bipolar transistor - basic application circuits. Small- and large-signal equivalent circuits. A band of amplified frequencies and switchig times for pulse operation. Photodiodes and solar cells - operation principles, used materials and constructions. Important application-type parameters. Operation in basic application circuits. Electroluminescent diodes and semiconductor lasers - operation principles, used materials and constructions. Heterojunctions. Important application-type parametrs. Basic application circuits. Families of electronic devices - devices for integrated circuits, power devices, microwave devices. Trends in device development.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>A student should have a basic knowledge and skills in using methods of mathematical calculus, linear algebra, electricity part of physics, as taught at undergraduate courses of universities. If he/she studied at our University he/she should obtain a positive grades in Mathematical Analysis, Linear Algebra, Physics prior to studying the Semiconductor Devices.</td></tr>
<tr><td>Assessment methods and criteria</td><td>
<table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Test written at the end of a term</td><td>50.0%</td><td>100.0%</td></tr>
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<tr><td>Recommended reading</td><td>
<table>
<tr><td>Basic literature</td><td>Ch.C. Hu, Modern Semiconductor Devices for Integrated Circuits, Prentice Hall 2009</td></tr>
<tr><td>Supplementary literature</td><td>A.S. Sedra, K.C. Smith, "Microelectronic Circuits", Oxford, 2007

Ch. Papadopoulos, "Solid-State Electronic Devices: An Introduction", Springer 2014

M. Grundmann, The Physics of Semiconductors: An Introduction Including Nanophysics and Applications, 2ed., Springer 2010

J.-P. Colinge, C.A. Colinge, "Physics of Semiconductor Devices", Springer 2002</td></tr>
<tr><td>eResources addresses</td><td>Przyrządy Półprzewodnikowe 2022 - ACiR, IBM - sem. 2 - Moodle ID: 22596
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=22596</td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td>There are given parameter values of a device, e.g. for n-channel MOSFET – of a threshold voltage and of a beta parameter (i.e. product of electron mobility, capacitance per unit of area and a channel width divided by a length). There is given a biasing circuit containing a battery and several resistors. Calculate values of the gate-source and drain-source voltages and of the drain current.

In addition, there is connected an AC current source of small amplitude and known frequency. Calculate the amplitude value of the drain-source voltage AC component.</td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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