GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Semiconductor Devices, PG_00067326		
Field of study	Automatic Control, Cybernetics and Robotics		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2025/2026
Education level	first-cycle studies	Subject group	Obligatory subject group in the field of study Subject group related to scientific research 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 -> Wydziały Politechniki Gdańskiej		
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	15.0	0.0	0.0	0.0	30

E-learning hours included: 0.0

eNauczanie source address: https://enauczanie.pg.edu.pl/moodle/course/view.php?id=40387

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	30	2.0	18.0	50

Subject objectives

Learning basic properties of main-stream semiconductor devices at the level enabling analysis and design of simple application circuits. Qualitative understanding operation principles of main-stream semiconductor devices. The lecture presents the theory, while the practice build the long-term knowledge.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[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 application	[SW1] Assessment of factual knowledge
[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

Subject contents	Lecture 1 h. General, qualitatively presented idea of a transistor as a device with a potential barrier that can regulate flow of electrons or holes from a high-energy reservoir to a low-energy reservoir. 2 h. MOS FET operation principle presented qualitatively, using the above introduced model. Static and dynamic characteristics. Small-signal equivalent circuit of a MOS FET. Possibilities created with contemporary constructions of MOS FETs in integrated circuits and limitations related to them. 1 h. Using static characteristics and small signal-equivalent circuits of MOS FETs for calculation of DC and AC components of currents and voltages of MOS FETs in applications. 2 h. Physical properties of semiconductors - conduction and valence bands, concentration of electrons and holes, transport of electrons and holes: drift-diffusion, tunneling, ballistic. 2 h. Semiconductor diode as a nonsymmetric element with a built-in potential barrier that enables regulation of a current value with the applied voltage qualitatively presented static characteristics. Junction and diffusion capacitances small-signal and charge-control equivalent circuits. 1 h. Using static characteristics and small signal-equivalent circuits of diodes for calculation of DC and AC components of currents and voltages of diodes in applications. 2 h. Operation principle of a bipolar transistor presented qualitatively, using the above introduced model. Static and dynamic characteristics. A small signal-equivalent circuit of a bipolar transistor. 1 h. Using static characteristics and small signal-equivalent circuits of bipolar transistors for calculation of DC and AC components of currents and voltages of bipolar transistors in applications. 2 h. Qualitatively presented operation principles of optoelectronic devices light emitting diodes, as well as photodiodes and solar cells; taking into account applications of organic semiconductors. 1 h. Power semiconductor devices, integrated circuits, and trends in their development. Practice 1 h. Introduction to using closed loop equations and the Thevenin theorem, applied to circuits containing many-electrode elements, like transistors. 3 h. Determining DC currents and voltages of MOS FETs in simple application circuits. Determining the operation areas of MOS FETs. 2 h. Determining parameters of small-signal equivalent circuits of MOS FETs in simple application circuits. Application of these equivalent circuits for calculation of AC currents and voltages. 2 h. Determining the operation areas of pn diodes. Calculation of DC currents and voltages pn diodes in simple application circuits. 2 h. Determining parameters of small-signal equivalent circuits of pn diodes in simple application circuits, in different operation areas. Application of these equivalent circuits for calculation of AC currents and voltages. 2 h. Determining DC currents and voltages of bipolar transistors in simple application circuits. Determining the operation areas of bipolar transistors. 2 h. Determining parameters of small-signal equivalent circuits of bipolar transistors in simple application circuits. Application of these equivalent circuits for calculation of AC currents and voltages. 1 h. Determining the operation areas of optoelectronic devices in simple application circuits. Determining DC currents and voltages. Application of these equivalent circuits of optoelectronic devices.
Prerequisites and co-requisites	A student should have a basic knowledge and skills in using methods of mathematical calculus, linear algebra, as well as elementary knowledge on electricity part of physics and elementary knowledge on circuits and signals. If he/she studied at our University he/she should finish courses in Mathematical Analysis, Linear Algebra and Elementary Mathematics prior to studying the Semiconductor Devices.
Assessment methods and criteria	

Subject passing criteria	Passing threshold	Percentage of the final grade
Test No.3 written during a term	50.0%	33.0%
Test No.2 written during a term	50.0%	33.0%
Test No.1 written during a term	50.0%	34.0%

Recommended reading		
	Basic literature	Ch.C. Hu, Modern Semiconductor Devices for Integrated Circuits, Prentice Hall 2009
	Supplementary literature	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
	eResources addresses	Basic https://people.eecs.berkeley.edu/~hu/Book-Chapters-and-Lecture-Slides-download.html - Chenming C. Hu, Modern Semiconductor Devices for Integrated Circuits, Pearson; 2009

Example issues/ example questions/ tasks being completed	There are given design parameter values of a device, e.g. for n-channel MOSFET of a threshold voltage and of a beta parameter (i.e. the product of electron mobility, capacitance per unit of area and a channel width divided by a length). There is known an application circuit containing a battery and several resistors. Calculate the value of the DC component of the gate-source voltage for the required, known value of the DC drain current. Determine the operation region of the transistor. Calculate the value of charges stored at the capacitances of the transistor. In addition, there is connected an AC current source of a small amplitude and known frequency. Calculate the amplitude value of the source current AC component.
Work placement	Not applicable

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