GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Electronic Devices, PG_00047900		
Field of study	Electronics and Telecommunications		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2026/2027
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	2	Language of instruction	Polish
Semester of study	3	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	exam
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 dr inż. Maciej Kokot dr hab. inż. Anna Pietrenko-Dąbrowska	

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

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	3.0	42.0	75

Subject objectives

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

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 commonly used semiconductor devices to their main, usually specified electrical and design parameters; can apply this knowledge and the acquired methods to determine properties of these devices in basic applications	[SW1] Assessment of factual knowledge
[K6_U02] can perform tasks related to the field of study in an innovative way as well as solve complex and nontypical problems, applying knowledge of physics, in changing and not fully predictable conditions	can apply the acquired knowledge on the mechanisms of operation of semiconductor devices to determine their properties in not typical applications, eg. applied as sensors	[SU1] Assessment of task fulfilment
[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 fundamental laws of semiconductor physics and thermodynamics, eg. can estimate an influence of a potential barrier height at a device or of a biasing voltage polarization on electrical current flow	[SW1] Assessment of factual knowledge

Subject contents	Structure of a semiconductor crystal, a conduction band and a valence band. Concentration of electrons and holes in a semiconductor. Generation and recombination of electrical carriers, effects of strong electric fields, temperature effects. 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. Influence of construction parameters and of secondary physical effects - presented by comparing actual and ideal characteristics. 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 of an ideal device. Comparison with characteristics of contemporary transistors. Charges and capacitancies in the transistor structure. Temperature effects. 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.
Prerequisites and co-requisites	A student should have a basic knowledge and skills in using methods of mathematical calculus, linear algebra, electricity part of physics, and electrical circuits and signals, 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, Circuits and Signals prior to studying the Electronic Elements.
Assessment methods and criteria	

Subject passing criteria	Passing threshold	Percentage of the final grade
Written exam	50.0%	100.0%

Recommended reading	Basic literature	Ch.C. Hu, Modern Semiconductor Devices for Integrated Circuits, Pearson 2009 J.-P. Colinge, C.A. Colinge, "Physics of Semiconductor Devices", Springer 2002
	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 S.M. Sze, Kwok K. Ng, "Physics of Semiconductor Devices", 3 ed., Wiley, 2006
	eResources addresses	Adresy na platformie eNauczanie:
Example issues/ example questions/ tasks being completed	There are given design parameter values of a device, e.g. for n-channel MOSFET –electron mobility, capacitance per unit of area of a gate, a channel width and length, and a threshold voltage. 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 amplitude value of the drain-source voltage AC component.	
Work placement	Not applicable	

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