



## Subject card

Subject name and code	Semiconductor Devices, PG_00047545						
Field of study	Automatic Control, Cybernetics and Robotics						
Date of commencement of studies	October 2024		Academic year of realisation of subject		2024/2025		
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						
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_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		
	[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	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.		
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, 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.		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Test written at the end of a term	50.0%	100.0%
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  J.-P. Colinge, C.A. Colinge, "Physics of Semiconductor Devices", Springer 2002	
	eResources addresses	Adresy na platformie eNauczanie:	
Example issues/ example questions/ tasks being completed	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.		
Work placement	Not applicable		