GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Basics of molecular electronics, PG_00064049		
Field of study	Technical Physics		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2026/2027
Education level	first-cycle studies	Subject group	Optional subject group 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	3	Language of instruction	Polish
Semester of study	6	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Division of Molecular Photophysics -> Institute of Physics and Applied Computer Science -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Waldemar Stampor	
	Teachers		

Lesson types

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 addresses:

Moodle ID: 46323 Podstawy elektroniki molekularnej FT 2026
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=46323

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	5.0	15.0	50

Subject objectives

To acquaint students with basics of molecular electronics.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U02] analyzes and solves simple scientific and technical problems, based on possessed knowledge, using analytical, numerical, simulation and experimental methods	Has an idea of the role of organic materials in some modern fields of technology and in everyday life	[SU2] Assessment of ability to analyse information
[K6_W02] has systematized knowledge of the basics of physics, including mechanics, thermodynamics, electricity and magnetism, optics, atomic and particle physics, solid-state physics, nuclear and elementary particle physics	Understands the optical, electrical and optoelectronic phenomena underlying organic electronic devices	[SW1] Assessment of factual knowledge

Subject contents

Course content – lecture
LECTURE: Introduction. Properties of molecules. Molecular solids Electronic excited states in molecular systems.. Transport of charge carries in molecular solids. Injection-limited currents. The currents of charge carriers of one sign. The currents of charge carriers of two signs. Electroluminescence. Photovoltaic phenomenon. Basic elements of molecular electronics.

Course content – exercises
TUTORIALS: Electric dipole. Electric multipoles. Electric polarizability of atom. Lorentz local field. Claussius-Mossotti equation. Orientation polarization. Langevin function. Debyes equation. Van der Waals interactions between molecules. Wanier - Mott and Frenkel excitons. Radius and energy of an exciton. Exciton diffusion in a crystal. Schottky effect at a metal/semiconductor junction. Drift and diffusion currents. Childs Law.. Space charge limited (SCL) currents with exponential distribution of traps. Current-voltage curves for SCL currents. Bimolecular recombination. Langevin recombination coefficient.

<table>
<tr><td>Prerequisites and co-requisites</td><td colspan="3">Student defines basic terms concernig structure of matter. Student lists basic types of electronics. Student uses basic physical terms.</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="3"><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Tutorial</td><td>50.0%</td><td>40.0%</td></tr>
<tr><td>Writen exam</td><td>50.0%</td><td>30.0%</td></tr>
<tr><td>Oral exam</td><td>50.0%</td><td>30.0%</td></tr>
</table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td colspan="2">1. J. Godlewski, Wstęp do elektroniki molekularnej, Politechnika Gdańska, 2008

2. M. Schwoerer, H.C.Wolf, Organic Molecular Solids, Wiley 2006.</td></tr>
<tr><td>Supplementary literature</td><td colspan="2">1. A.Kohler, H.Bassler, Electronic processes in organic semiconductors, Wiley, 2015.

2. J. Kalinowski, Organic Light-Emitting Diodes, Marcel Dekker, New York, 2005.

3. H. Haken, H.C. Wolf, Fizyka molekularna z elementami chemii kwantowej, PWN, W-wa 1998.

4. S.Forrest, Organic electronics, Oxford University Press, Oxford 2020.</td></tr>
<tr><td>eResources addresses</td><td colspan="2"></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="3">Types of excitons

Photophysical processes on the Jabłoński diagram.

Space charge limited currents. Child's law.

The Langevin mechanism of bimolecular recombination.

The principle of operation of organic electronics devices: photovoltaic cell, electroluminescent diode, field effect transistor.</td></tr>
<tr><td>Practical activites within the subject</td><td colspan="3">Not applicable</td></tr>
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