GDAŃSK UNIVERSITY
OF TECHNOLOGY

Subject card

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| Subject name and code | Solid state electronics and nanoelectronics, PG_00071207 | | |
| Field of study | Nanotechnology, Nanotechnology | | |
| Date of commencement of studies | February 2027 | Academic year of realisation of subject | 2026/2027 |
| Education level | second-cycle studies | Subject group | Specialty subject group<br>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 | English |
| Semester of study | 1 | ECTS credits | 3.0 |
| Learning profile | general academic profile | Assessment form | exam |
| Conducting unit | Division of Nanomaterials Physics -> Institute of Nanotechnology and Materials Engineering -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology | | |
| Name and surname of lecturer (lecturers) | Subject supervisor | prof. dr hab. inż. Barbara Kościelska | |
| | Teachers | prof. dr hab. inż. Barbara Kościelska | |

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| Lesson types | Lesson type | Lecture | Tutorial | Laboratory | Project | Seminar | SUM |
| | Number of study hours | 30.0 | 0.0 | 0.0 | 0.0 | 0.0 | 30 |
| | E-learning hours included: 0.0 | | | | | | |

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| 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 | 43.0 | 75 |

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| Subject objectives | The aim of the course is to acquire knowledge, skills and competence in the field of solid state electronics and nanoelectronics. |

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| Learning outcomes | Course outcome | Subject outcome | Method of verification |
| | [K7_W02] has in-depth, theoretically grounded and detailed knowledge of phenomena, methods, and theories related to nanotechnology, as well as of related and allied fields of science or engineering | The student has in-depth knowledge of solid state electronics and nanoelectronics. | [SW1] Assessment of factual knowledge |
| | [K7_W03] has knowledge of current development trends and the latest discoveries in the fields of physics, chemistry, technology, and applications of nanostructures | The student has knowledge of current developments in the field of solid-state electronics and nanoelectronics. | [SW1] Assessment of factual knowledge |
| | [K7_U06] is able to apply acquired specialist knowledge to problems in other physical, natural, or technical sciences and to critically analyze and evaluate the functioning of the adopted solutions | The student is able to apply knowledge of physics and nanotechnology to issues related to solid state electronics and nanoelectronics. | [SU3] Assessment of ability to use knowledge gained from the subject |

**Subject contents**

Course content – lecture
1. Introduction.

2. Physics and properties of solids - a review

2.1. Density of states in 0D, 1D, 2D and 3D materials.

2.2. Band structure of solids: free electron, nearly free electron and tight binding model.

2.3. Energy bands and carrier concentration in thermal equilibrium.

2.4. Electrical and thermal conduction in solids: carrier transport phenomena.

2.5. Kinetic phenomena in semiconductors.

3. Metal-semiconductor junctions and p-n junctions.

4. Diodes: Schottky diode, p-n diode, MIS, MOS, tunnel diode, resonant-tunneling diode.

5. Transistors: bipolar, FET, hot-electron HET and THET, single-electron transistor.

6. Light emitting diodes and lasers.

6.1. Light emitting diodes.

6.2. Semiconductor lasers.

6.3. Quantum-cascade laser.

7. Photodetectors and solar cells.

8. Tunnel phenomena in superconductors: Josephson junction.

9. Spintronic devices.

10. Semiconductor technology.

10.1. Crystal growth and epitaxy.

10.2. Film formation.

10.3. Lithography and etching.

10.4. Impurity doping.

**Prerequisites and co-requisites**

Completed courses in the field of basics of nanotechnology and solid state physics (or physics of materials).

**Assessment methods and criteria**

| Subject passing criteria | Passing threshold | Percentage of the final grade |
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| written test | 50.0% | 100.0% |

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| Recommended reading | Basic literature | 1. S.O. Kasap "Principles of electronic materials and devices", McGraw-Hill, 2006,<br>3rd ed. (El 178223-00-00/01)<br>2. S.M. Sze, Kwok K. Ng, Physics of Semiconductor Devices, John Wiley & Sons, 2007, 3rd ed. (FM 304796-00-00/01) |
| | Supplementary literature | 1. S.M. Sze, M.K. Lee Semiconductor Devices, Physics and Technology,<br>John Wiley & Sons, 2012, 3rd ed. |
| | eResources addresses | |
| Example issues/ example questions/ tasks being completed | Describe metal-semiconductor junction<br>Describe MOS diode<br>Describe single electron transistor<br>Describe quantum-cascade laser | |
| Practical activites within the subject | Not applicable | |

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