GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Microelectromechanical Systems, PG_00064021		
Field of study	Electronics and Telecommunications		
Date of commencement of studies	February 2027	Academic year of realisation of subject	2026/2027
Education level	second-cycle studies	Subject group	Optional subject group Specialty 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	1	Language of instruction	Polish
Semester of study	1	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Microelectronic Systems -> Faculty of Electronics Telecommunications and Informatics -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Piotr Płotka	
	Teachers	dr inż. Piotr Kurgan dr hab. inż. Piotr Płotka	

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	15.0	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	4.0	16.0	50

Subject objectives

Introduction to MEMS technologies, presentation of recent developments in MEMS, as well as teachig of application of tools used for simulating of electronic circuits for designing of MEMS.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W10] knows and understands, to an increased extent, the basic processes occurring in the life cycle of equipment, objects and technical systems, as well as methods of supporting processes and functions, specific to the field of study	Recognizes and understands possibilities of application of MEMS modules for designing of save, efficient and automated systems and processes.	[SW1] Assessment of factual knowledge
[K7_U02] can perform tasks related to the field of study as well as formulate and solve problems applying recent knowledge of physics and other areas of science	Is able to apply his already gained knowledge in physics and chemistry for modelling of operation of MEMS elements which he/she did not know earlier	[SU1] Assessment of task fulfilment
[K7_W03] knows and understands, to an increased 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 construction and operation mechanisms of basic MEMS elements representative for applications in various fields	[SW1] Assessment of factual knowledge
[K7_U07] can apply advanced methods of process and function support, specific to the field of study	is able to apply creatively computer aided design tools developed for electrical circuits in order to design complex electromechanical systems	[SU1] Assessment of task fulfilment

<table>
<tr><td>Subject contents</td><td>Course content – lecture
Lectures:
1.Introduction. Evolution of microelectromechanical systems and markets.
2. MEMS fabrication and materials - patterning, etching, deposition and stress control.
3. MEMS fabrication and materials - bonding, heterogeneous integration, packaging and mechanical property.
4. Review of MEMS elements and their fabrication sensors.
5. Review of MEMS elements and their fabrication actuators, energy sources.
6. Applications of MEMS - automobile & home, information processing & telecommunication
7. Applications of MEMS biomedical & chemical
8. Application of electronic circuits simulators for electromechanical simulations: current force analogy
9. Application of electronic circuits simulators for electromechanical simulations: voltage force analogy
10. Design of mechanical elements beams and springs
11. Design of mechanical MEMS elements with beams and springs
12. Design of mechanical MEMS elements with mechanical resonance
13. Design of MEMS elements for electronic applications at radio frequencies.
14. Design of MEMS elements with piezo-elements.
15. Integration of MEMS and electronic circuits.

Lab:

Investigation of a beam type model of a MEMS resonator with capacitive coupling
Applications of accelerometers in a wing model
Applications of pressure sensors in a wing model
Investigation of MEMS accelerometers, inclinometers and gyroscopes
Frequency stabilization with MEMS resonators</td></tr>
<tr><td>Prerequisites and co-requisites</td><td></td></tr>
<tr><td>Assessment methods and criteria</td><td>
<table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Midterm colloquium</td><td>50.0%</td><td>50.0%</td></tr>
<tr><td>Practical exercises</td><td>50.0%</td><td>50.0%</td></tr>
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<tr><td>Recommended reading</td><td>
<table>
<tr><td>Basic literature</td><td>W. K. Schomburg, Introduction to Microsystem Design, Springer 2011

V.K. Varadan, K.J. Vinoy, K. A. Jose, U. Zoelzer, RF Mems & Their Applications, Wiley 2002

M. Esashi, Premium Tutorial, The 11th. Annual IEEE Int. Conf. on Nano/ Micro Engineered and Molecular Systems (IEEE-NEMS 2016), Matsushima and Sendai, Japan, 17-20 April, 2016</td></tr>
<tr><td>Supplementary literature</td><td>T. M. Adams, R. A. Layton, Introductory MEMS. Fabrication and Applications, Springer 2010

B. Bhushan (ed.), "Springer Handbook of Nanotechnology", Springer-Verlag, 2004.

H. J. de Los Santos, RF MEMS Circuit Design for Wireless Communications, Artech 2002

N. Maluf, K. Williams, An Introduction to Microelectromechanical Systems Engineering, 2 ed., Artech 2004

S. Carrara, "Bio/CMOS Interfaces and Co-Design", Springer 2013</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td>Silicon micromachining: surface and bulk. Process LIGA. Bio- and chemical sensors and actuators. Nano- and micro- MEMS technology in optoelectronics. Using of MEMS technology in making tunable capacitors. Silicon micromotors. Selection of design parameters and electromechanical testing of a beam-type resonator with a capacitive coupling.</td></tr>
<tr><td>Practical activites within the subject</td><td>Not applicable</td></tr>
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