



Subject card

Subject name and code	Microelectromechanical Systems, PG_00048580						
Field of study	Electronics and Telecommunications						
Date of commencement of studies	February 2023	Academic year of realisation of subject			2022/2023		
Education level	second-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	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						
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	15.0	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 teaching of application of tools used for simulating of electronic circuits for designing of MEMS.						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	[K7_W05] Knows and understands, to an increased extent, methods of process and function support, specific to the field of study.	knows and understands methods used for simulation tools for electronic circuits, which are useful also in MEMS design			[SW1] Assessment of factual knowledge		
	[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		
	[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 study necessary topics in physics and chemistry and apply the gained knowledge for modelling of operation of MEMS elements which he/she did not know earlier			[SU1] Assessment of task fulfilment		
	[K7_U06] can analyse the operation of components, circuits and systems related to the field of study; measure their parameters; examine technical specifications; interpret obtained results and draw conclusions	knowing the theoretical methods developed for analysis of electronic circuits and electro-mechanical analogies, applies them for analyses of systems containing mechanical as well as electronic elements			[SU1] Assessment of task fulfilment		

Subject contents	<p>1. Introduction. Evolution of microelectromechanical systems and markets.</p> <p>2. MEMS fabrication and materials - patterning, etching, deposition and stress control.</p> <p>3. MEMS fabrication and materials - bonding, heterogeneous integration, packaging and mechanical property.</p> <p>4. Review of MEMS elements and their fabrication – sensors.</p> <p>5. Review of MEMS elements and their fabrication – actuators, energy sources.</p> <p>6. Applications of MEMS - automobile & home, information processing & telecommunication</p> <p>7. Applications of MEMS – biomedical & chemical</p> <p>8. Application of electronic circuits simulators for electromechanical simulations: current – force analogy</p> <p>9. Application of electronic circuits simulators for electromechanical simulations: voltage – force analogy</p> <p>10. Design of mechanical elements – beams and springs</p> <p>11. Design of mechanical MEMS elements with beams and springs</p> <p>12. Design of mechanical MEMS elements with mechanical resonance</p> <p>13. Design of MEMS elements for electronic applications at radio frequencies.</p> <p>14. Design of MEMS elements with piezo-elements.</p> <p>15. Integration of MEMS and electronic circuits</p>											
Prerequisites and co-requisites												
Assessment methods and criteria	<table border="1"> <thead> <tr> <th data-bbox="453 1375 794 1406">Subject passing criteria</th> <th data-bbox="799 1375 1141 1406">Passing threshold</th> <th data-bbox="1145 1375 1485 1406">Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td data-bbox="453 1413 794 1444">Practical exercises</td> <td data-bbox="799 1413 1141 1444">50.0%</td> <td data-bbox="1145 1413 1485 1444">50.0%</td> </tr> <tr> <td data-bbox="453 1451 794 1482">Midterm colloquium</td> <td data-bbox="799 1451 1141 1482">50.0%</td> <td data-bbox="1145 1451 1485 1482">50.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade	Practical exercises	50.0%	50.0%	Midterm colloquium	50.0%	50.0%
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Practical exercises	50.0%	50.0%										
Midterm colloquium	50.0%	50.0%										
Recommended reading	Basic literature	<p>W. K. Schomburg, Introduction to Microsystem Design, Springer 2011</p> <p>V.K. Varadan, K.J. Vinoy, K. A. Jose, U. Zoelzer, RF Mems & Their Applications, Wiley 2002</p> <p>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</p>										

	Supplementary literature	<p>T. M. Adams, R. A. Layton, Introductory MEMS. Fabrication and Applications, Springer 2010</p> <p>B. Bhushan (ed.), "Springer Handbook of Nanotechnology", Springer-Verlag, 2004.</p> <p>H. J. de Los Santos, RF MEMS Circuit Design for Wireless Communications, Artech 2002</p> <p>N. Maluf, K. Williams, An Introduction to Microelectromechanical Systems Engineering, 2 ed., Artech 2004</p> <p>S. Carrara, "Bio/CMOS Interfaces and Co-Design", Springer 2013</p>
	eResources addresses	Adresy na platformie eNauczenie:
Example issues/ example questions/ tasks being completed	Silicon micromachining: surface and bulk. Proces LIGA. MEMS and nanotechnology in massive data storage systems. Bio- and chemical sensors and actuators. Nano- i MEMS technology in optoelectronics. Shape memory alloys in MEMS technology. Using of MEMS technology in making tunable capacitors. Silicon micromotors.	
Work placement	Not applicable	