



## Subject card

Subject name and code	Hardware Support of Artificial Intelligence Algorithms, PG_00064019						
Field of study	Electronics and Telecommunications						
Date of commencement of studies	February 2025		Academic year of realisation of subject		2024/2025		
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						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Waldemar Jendernalik				
	Teachers		dr hab. inż. Waldemar Jendernalik				
Lesson types and methods of instruction	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		3.0		17.0	50
Subject objectives	The student learns about the design of integrated circuits supporting artificial intelligence algorithms.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	[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		The student knows the methods, techniques and problems related to the design of integrated circuits intended to support artificial intelligence algorithms.		[SW1] Assessment of factual knowledge		
	[K7_U07] can apply advanced methods of process and function support, specific to the field of study		The student can correctly select software tools to implement design processes.		[SU4] Assessment of ability to use methods and tools		
	[K7_W04] knows and understands, to an increased extent, the principles, methods and techniques of programming and the principles of computer software development or programming devices or controllers using microprocessors or other elements or programmable devices specific to the field of study, and organization of work of systems using computers or such devices		The student has in-depth knowledge of professional computer tools for designing large-scale integrated circuits.		[SW1] Assessment of factual knowledge		
	[K7_K02] is ready to provide critical evaluation of received content and to acknowledge the importance of knowledge in solving cognitive and practical problems		The student uses knowledge from lectures and laboratories to solve practical problems in the design of large-scale-integrated systems.		[SK5] Assessment of ability to solve problems that arise in practice		

Subject contents	<p>1. Artificial Intelligence (AI) - basic terms and definitions.</p> <p>2. Problems/limitations related to physical implementation.</p> <p>3. Integrated circuits for supporting AI - a review of selected solutions.</p> <p>4. Implementation of operators and functions (addition, multiplication, convolution, etc.) in integrated circuits.</p> <p>5. Problems of performance, power consumption and area.</p>		
Prerequisites and co-requisites	No requirements		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Practical exercises	60.0%	100.0%
Recommended reading	Basic literature	1.	
	Supplementary literature	<p>O. Dreessen. Introduction to Convolutional Neural Networks: What Is Machine Learning?Part 1. Analog Dialogue Magazine, vol. 57, Feb. 2023. <a href="https://www.analog.com/en/resources/analog-dialogue/articles/max78000-article-series-part-1.html">https://www.analog.com/en/resources/analog-dialogue/articles/max78000-article-series-part-1.html</a></p> <p>O. Dreessen.Training Convolutional Neural Networks: What Is Machine Learning?Part 2. Analog Dialogue Magazine, vol. 57, Mar. 2023. <a href="https://www.analog.com/en/resources/analog-dialogue/articles/training-convolutional-neural-networks-what-is-machine-learning-part-2.html">https://www.analog.com/en/resources/analog-dialogue/articles/training-convolutional-neural-networks-what-is-machine-learning-part-2.html</a></p> <p>O. Dreessen. Hardware Conversion of Convolutional Neural Networks: What Is Machine Learning?Part 3. Analog Dialogue Magazine, vol. 57, Apr. 2023. <a href="https://www.analog.com/en/resources/analog-dialogue/articles/hardware-conversion-of-cnns-what-is-machine-learning-part-3.html">https://www.analog.com/en/resources/analog-dialogue/articles/hardware-conversion-of-cnns-what-is-machine-learning-part-3.html</a></p> <p>Dudek, P.; Richardson, T.; Bose, L.; Carey, S.; Chen, J.; Greatwood, C.; Liu, Y.; Mayol-Cuevas, W. Sensor-level computer vision with pixel processor arrays for agile robots. Sci. Robot. 2022. DOI: 10.1126/scirobotics.abl7755.</p> <p>W. Shan et al. A 510nW 0.41V Low-Memory Low-Computation Keyword-Spotting Chip Using Serial FFT-Based MFCC and Binarized Depthwise Separable Convolutional Neural Network in 28nm CMOS. ISSCC 2022, USA. DOI: 10.1109/ISSCC19947.2020.9063000.</p> <p>K. Kim et al. A 23W Solar-Powered Keyword-Spotting ASIC with Ring-Oscillator-Based Time-Domain Feature Extraction. ISSCC 2022, USA. DOI: 10.1109/ISSCC42614.2022.9731708.</p> <p>M. Yang et al. Design of an always-on deep neural network-based 1 <math>\mu</math>W voice activity detector aided with a customized software model for analog feature extraction. IEEE JSSC, 2019. DOI: 10.1109/JSSC.2019.2894360.</p> <p>M. Lefebvre et al. A 0.2-to-3.6TOPS/W Programmable Convolutional Imager SoC with In-Sensor Current-Domain Ternary-Weighted MAC Operations for Feature Extraction and Region-of-Interest Detection. IEEE ISSCC 2021. DOI: 10.1109/ISSCC42613.2021.9365839.</p>	
	eResources addresses	Adresy na platformie eNauczanie:	

Example issues/ example questions/ tasks being completed	
Work placement	Not applicable

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