



## Subject card

Subject name and code	Application of FPGA and CPLD in DSP, PG_00048110						
Field of study	Electronics and Telecommunications						
Date of commencement of studies	October 2024	Academic year of realisation of subject			2027/2028		
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	4	Language of instruction			Polish		
Semester of study	7	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 inż. Miron Kłosowski					
	Teachers	dr inż. Miron Kłosowski					
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	2.0		18.0		50
Subject objectives	The aim of the course is to provide students with the basic knowledge and skills in the design of hardware digital signal processing systems using FPGA technology and VHDL. As a result, students will be prepared to work in companies producing DSP systems using FPGAs or ASICs and students will be able to participate in specialized software development.						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	[K6_W32] Knows the parameters, functions and methods of analysis, design and optimization of analogue and digital circuits and electronic systems	Student specifies functional blocks of DSP systems. Student describes methods of representing DSP algorithms. Student knows the methods of DFG graph optimization. Student understands the concepts of redundant and distributed arithmetic. Student knows the hardware techniques of digital filters implementation.			[SW1] Assessment of factual knowledge		
	[K6_U04] can apply knowledge of programming methods and techniques as well as select and apply appropriate programming methods and tools in computer software development or programming devices or controllers using microprocessors or programmable elements or systems specific to the field of study	Student designs and implements digital filters using FPGAs. Student measures the characteristics of the implemented filters.			[SU1] Assessment of task fulfilment		

Subject contents	1. Hardware implementation of DSP systems - introduction. 2. Hardware implementation of FIR digital filters. 3. Automatic DSP modules generation. 4. Hardware implementation and applications of Cascaded Integrator Comb filters. 5. Hardware implementation of IIR digital filters. 6. Rank order filters, median filters. 7. Hardware implementation of DCT and FFT algorithms. 8. Architecture and applications of CORDIC module. 9. Hardware implementation of digital signal synthesis. 10. DSP functional blocks in FPGA circuits architecture and properties. 11. Sample applications of DSP systems based on FPGAs. 12. Description methods of DSP systems. 13. Basic properties of Data Flow Graphs. 14. Iteration bound calculation of DFG using LPM method. 15. Pipeline processing on FIR filter example. 16. Parallel processing on FIR filter example. 17. Power efficiency of pipeline and parallel processing. 18. Retiming. Retiming algorithms. K-slow transform. 19. Unfolding - properties and applications. 20. Folding - properties and applications. 21. Systolic arrays. 22. Canonic Signed Digit arithmetics. 23. Distributed arithmetic. 24. Redundant arithmetic. 25. Numerical strength reduction.		
Prerequisites and co-requisites			
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Practical exercise	50.0%	50.0%
	Midterm colloquium	50.0%	50.0%
Recommended reading	Basic literature	<ol style="list-style-type: none"> <li>1. Keshab K. Parhi, "VLSI Digital Signal Processing Systems - Design and Implementation", John Wiley and Sons, Inc; 1999.</li> <li>2. Tomasz P. Zieliński, "Cyfrowe przetwarzanie sygnałów - od teorii do zastosowań", Wydawnictwa Komunikacji i Łączności, Warszawa 2005.</li> </ol>	
	Supplementary literature	No requirements	
	eResources addresses	Adresy na platformie eNauczanie:	
Example issues/ example questions/ tasks being completed	Design using any method low-pass FIR filter with provided parameters and implement it on the laboratory evaluation board.		
Work placement	Not applicable		