GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Programmable Circuits, PG_00068224		
Field of study	Biomedical Engineering		
Date of commencement of studies	October 2025	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	3	Language of instruction	Polish
Semester of study	6	ECTS credits	3.0
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 inż. Miron Kłosowski	
	Teachers	dr inż. Miron Kłosowski	

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

eNauczanie source address: https://enauczanie.pg.edu.pl/moodle/course/view.php?id=42637

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

Subject objectives

The aim of the course is to provide students with basic knowledge and skills in the design and simulation of digital electronic systems implemented in FPGA technology using the VHDL language. Thanks to this subject, students will be prepared for professional implementation of advanced hardware-software systems using FPGA technology and will be able to participate in the production of specialized EDA software for simulation and synthesis of digital systems.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U12] can analyze the operation of components, circuits and systems related to the field of study, as well as measure their parameters and examine technical specifications, and plan and conduct experiments related to the field of study, including computer simulations and measurements, and interpret obtained results and draw conclusions	The student develops testbench modules in VHDL and SystemC for the simulation of digital circuits. The student is able to find errors in a digital circuit based on the analysis of simulation results.	[SU1] Assessment of task fulfilment
[K6_W04] knows and understands, to an advanced extent, the principles, methods and techniques of programming and the principles of computer software development or programming devices or controllers using microprocessors or programmable elements or systems specific to the field of study, and organisation of systems using computers or such devices	The student describes the features of hardware description languages. The student knows the hardware description language VHDL. The student understands the processes of synthesis and simulation. The student is able to determine the conditions of code synthesis in VHDL language. The student knows the basics of SystemC environment. The student describes the structure and applications of FPGA systems. The student describes the methods of FPGA systems configuration.	[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	The student designs digital circuits using VHDL hardware description language. The student implements and tests digital systems in a real hardware and software environment based on FPGA. The student uses VHDL language for hardware implementation of simple algorithms.	[SU1] Assessment of task fulfilment

Subject contents

Course content – lecture
Lecture:

1. Introduction to VHDL, origin and applications. 2. Abstraction levels and description methods of digital circuits. 3. Design entity description in VHDL. 4. Assignments, signals, variables and operators in VHDL. 5. Data types in VHDL. 6. Resolution function. 7. Vectors and operations on vectors in VHDL. 8. Combinatorial processes. Synthesis of combinatorial logic in VHDL. 9. Project simulation in VHDL. 10. Conditional, case and loop statements in processes. 11. Constants and initial values of signals and variables. 12. Hierarchy and configuration of design entities. 13. Sequential processes in VHDL. 14. State machines. State encoding. Forbidden states. 15. Type conversion in VHDL. 16. Functions and procedures in VHDL. 17. Introduction to SystemC environment. 18. Applications of SystemC environment. 19. System design with hardware-software partitioning. 20. System on Chip technology. 21. Soft-processors - architecture and applications. 22. Programmable circuits taxonomy. 23. Architecture of FPGAs. 24. Configuration methods of FPGAs. 25. Hardware functional blocks in FPGAs. 26. Designing with constraints. 27. "Reconfigurable computing" as a programming paradigm. 28. Applications of RC in signal and image processing. 29. Algorithm representation in RC. 30. Arithmetic systems in RC. 31. Introduction to hardware-software co-design.

Laboratory:

1. VHDL implementation and simulation of a simple digital circuit.
2. VHDL Implementation and simulation of a digital circuit with a complex state machine.
3. VHDL implementation of I/O circuits for a soft-processor together with the implementation of simple application software.
4. Implementation of complex digital circuits using tools for the synthesis of functional blocks.
5. Implementation of a hardware-software system based on a soft-processor.
6. Simulation of a simple digital circuit using the SystemC environment.
7. Implementation of a selected System on Chip system.

Prerequisites and co-requisites

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Practical exercise	50.0%	70.0%
Midterm colloquium	50.0%	30.0%

Recommended reading	Basic literature	1. Frank Bruno, Guy Eschemann; The FPGA Programming Handbook: An Essential Guide to FPGA Design for Transforming Ideas into Hardware Using SystemVerilog and VHDL; Packt Publishing Ltd.; Birmingham, UK; 2024. 2. Zwoliński Mark; Projektowanie układów cyfrowych z wykorzystaniem języka VHDL; Wydawnictwa Komunikacji i Łączności WKŁ; Warszawa; 2007. 3. Cem Ünsalan, Bora Tar; Digital System Design with FPGA: Implementation Using Verilog and VHDL; McGraw-Hill Education; 2017.
	Supplementary literature	1. C. Bobda; Introduction to Reconfigurable Computing: Architectures, algorithms and applications; Springer; 2007. 2. David C. Black, Jack Donovan, Bill Bunton, Anna Keist; SystemC: From the Ground Up, Second Edition; Springer New York, NY; 2009. 3. Steve Kilts; Advanced FPGA Design: Architecture, Implementation, and Optimization; Wiley-IEEE Press, 2007.
	eResources addresses	Basic http://www.ue.eti.pg.gda.pl/biomed - Lecture content (slides), instructions for laboratory exercises, and other supporting materials.
Example issues/ example questions/ tasks being completed	Sample lab exercises: 1. Simple LED display driver. 2. Simple RS232 receiver and transmitter. 3. Video signal generator for VGA display. 4. Embedded system based on FPGA.	
Practical activites within the subject	Not applicable	

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