Bialystok University of Technology									
Field of study	**Computer Science**							**Degree level and programme type**	**Engineer's degree full-time programme**
Specialization/ diploma path	**---**							**Study profile**	academic
Course name	**Embedded Systems**							**Course code**	**FCS-00072**
								Course type	obligatory
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	**Semester**	2
	30				30			**No. of ECTS credits**	**6**
Entry requirements	Computer Organization and Architecture (FCS-00011),								
Course objectives	Familiarizing students with the methodology of designing embedded systems, embedded systems base technology and tools for the design of embedded systems. Learning how to use hardware description languages for the design of embedded systems. Learning the basics of embedded systems design using appropriate technological base. Learning methods for the use of external devices (keypad, LED and LCD displays, sensors). Implementation and testing of simple embedded systems.								
Course content	Lectures: Basic concepts related to the control and embedded systems. Types of architectures of microcontrollers, logic diagram of the microcontroller and its features, architecture, addressing modes, interrupt systems, power reduction. PIC microcontrollers family. Input-output ports, LED and LCD displays, timers, switches. CPLD and FPGA as a base for embedded systems. Hardware description languages with Verilog language for example. Real-time operating systems. Methodology for the design of embedded systems. Designing reliable embedded systems. Specialization wokshops: Design of combinational circuits in hardware description language: multiplexers, decoders, arithmetic circuits. Design of sequential circuits in hardware description language: registers, counters, timers, finite state machines, memories. Design of processors in hardware description language. Hardware implementation of algorithms. Design of simple filters.								
Teaching methods	informative lecture, lecture problem, programming, laboratory exercises, simulation,								
Assessment method	Lectures - written exam; specialization wokshops - evaluation of reports, answers on questions concerning designed projects								

Symbol of learning outcome	**Learning outcomes**	**Reference to the learning outcomes for the field of study**
LO1	knows the construction, operation and input-output interfaces of embedded systems	K_W02 K_W03
LO2	knows and understands the processes of design and manufacture of simple embedded systems on the base of microcontrollers and programmable logic devices.	K_W09
LO3	knows programming languages (Verilog) used in the design of embedded systems	K_W04
LO4	can implement a simple embedded system or its component, using appropriate methods, programming languages and tools, and taking into account the specified criteria.	K_U05
LO5	is able to formulate a simple embedded system specification and the specification of software and hardware components and can implement and test specified system.	K_W06 K_U05
LO6	can write a software for embedded systems using low-level languages, uses mechanisms and resources provided by these systems.	K_U05

Symbol of learning outcome	**Methods of assessing the learning outcomes**	**Type of tuition during which the outcome is assessed**
LO1	exam	L
LO2	exam	L
LO3	exam	L
LO4	Reports, observation of student's work	Sw
LO5	Report, realisation of project task, observation of student's work	Sw
LO6	Report, discussion on project and report, observation of student's work	Sw

Student workload (in hours)	**No. of hours**
1 - Attendance at lectures - 15x2h	30
2 - Attendance at specialization workshops - 15x2h	30
3 - Preparation for specialization workshops -	15
4 - Preparation of reports and realization of homeworks -	60
5 - Participation in student-teacher sessions -	5
6 - Preparation for the exam -	8
7 - Presence during exam -	2
TOTAL:	**150**

Quantitative indicators	**HOURS**	**No. of ECTS credits**
Student workload – activities that require direct teacher participation	67 (1)+(5)+(7)+(2)	2.7
Student workload – practical activities	105 (2)+(3)+(4)	4.2

Basic references	1. Taraate, Vaibbhav. Digital Logic Design Using Verilog. 2nd Ed. 2022 ed. Singapore: Springer Singapore. Web. 2. Chonnad, Shivakumar S, and Needamangalam B Balachander. Verilog. New York, NY: Springer New York, 2004. Web. 3. Jack Ganssle: Embedded hardware: Elsevier, 2008. 4. Tammy Noregaard: Embeded Systems Architecture, Elsevier, 2005. 5. Steve Kilts: Advanced FPGA design : architecture, implementation, and optimization. Hoboken : John Wiley a. Sons, 2007 336 p.
Supplementary references	1. Deschamps, Jean-Pierre, Enrique Cantó, and Gustavo D Sutter. Guide to FPGA Implementation of Arithmetic Functions. 1. Aufl. ed. Vol. 95. Dordrecht: Springer Netherlands, 2012. Lecture Notes in Electrical Engineering. Web. 2. Uwe Meyer-Baese: Digital signal processing with field programmable gate arrays. Berlin; Heidelberg: Springer, 2007. 774 p. 3. Patrick Lysaght: New algorithms, architectures and applications for reconfigurable computing. Dordrecht : Springer, 2005. 313 p. 4. Ashenden, Peter J. Digital Design (Verilog) : An Embedded Systems Approach Using Verilog. Amsterdam: Morgan Kaufmann, 2007. Web. 5. Frank Vahid, Tony Givargis: Embedded system design: a unified hardware/software introduction. New York : Wiley J., 2002.
Organisational unit conducting the course	Department of Digital Media and Computer Graphics — **Date of issuing the programme**
Author of the programme	dr inż. Adam Klimowicz — Feb. 17, 2022

L – lecture, C – classes, LC – laboratory classes, P – project, SW – specialization workshop, FW – field work,S – seminar