COURSE DESCRIPTION CARD

BIALYSTOK UNIVERSITY OF TECHNOLOGY		**Faculty of Electrical Engineering**	
Field of study	Electrical and Electronic Engineering	**Level and form of study**	Bachelor's degree, Full time
A group of modules /specialty		**Education profile**	General-academic
Course name	Analog-Digital Circuits	**Course code**	IS-FEE-10091S
		Course type	Elective
Course form(s) and number of hours	**L C LC P SW FW S** 15 30	**Semester** **ECTS credits**	**Summer** **3**
The programme is valid from	2025/2026		
Introductory courses	Introduction to Digital Technique and PLDs		
Course objectives	Analog-digital converters and hardware interfaces are key components of modern electronics. This course will enable you to develop the skills to design digital interfaces in PLD structures, understand signal conditioning and data conversion circuits, and learn about the applications of switched capacitor technology.		
Framework programme content	**Lectures**: Nyquist sampling. Anti-aliasing filters. Parallel analog-to-digital and digital-to-analog converters. Serial analog-to-digital and digital-to-analog converters. Voltage-to-frequency and frequency-to-voltage converters. Digital synthesis of a PWM signal. Implementation of I2C and SPI interfaces in FPGA. Switched capacitor stages. Field Programmable Analog Arrays architecture examples. **Laboratory classes**: FSM technology application in PWM signal synthesis. Defining I2C and SPI interfaces in VHDL. Support of analog-to-digital and digital-to-analog converters by FPGA chip. Applying serial buses in control systems. Opto-couplers in A-D systems. Digitization of small-signal analog circuits. Integrated C-switchable circuits. Digitally controlled transimpedance amplifier. FPAA design environment.		
Other information about the course	- the course is related to the scientific activity conducted at the University		

Calculation:

Student workload related to:	**Total number of hours**	**including contact**	**including practical**
participation in lectures	15	15	
participation in other forms of activities	30	30	30
participation in an examination	0	0	
participation in consultations	3	3	2
completion of professional training	0	0	0
preparation for passing a lecture/an examination	5		
preparation for practical classes	22		22
			0
			0
			0
			0
			0
			0
Total number of hours:	**75**	**48**	**54**
Total number of ECTS credits:	**3**	**1,9**	**2,2**

Expected discipline learning outcomes	Knowledge	Skills	Social competence

Objectives and framework content prepared by	Marian Gilewski, Ph.D. Eng.	Date:	

Implementation in the academic year **2025/2026**

Programme content

	Course forms I
1	An introduction to the sampling theorem
2	Aliasing effect
3	The basics of anti-aliasing low-pass filters
4	Analog-digital interface circuits
5	Synthesis of the SPI bus in an FPGA chip
6	Synthesis of an I2C bus in an FPGA chip
7	Synthesis of PWM signal in FPGA chip
8	Digital potentiometers
9	Digitally controlled current sources
10	Driving A/D and D/A converters with PLDs 1
11	Driving A/D and D/A converters with PLDs 2
12	Sampling circuits
13	Switched capacitor circuits
14	Digitally controlled amplifiers
15	FPAA architecture
	Course forms II
1	Synthesis of PWM signal and controllers of multi-digit displays in FPGAs
2	SPI controller implementation in FPGA
3	I2C controller implementation in FPGA
4	Phototransistors in opto-isolation, level conversion and logic circuits
5	Selected PWM applications
6	Hardware support for U/F and F/U converters
7	Control of serial A-D and D-A converters
8	Fast parallel A-D converter
9	Fast parallel D-A converter
10	Adjusting analog circuits digitally 1
11	Adjusting analog circuits digitally 2
12	Selected applications using switchable capacities

	13	C-switched transimpedance amplifier
	14	Handling the FPAA project environment 1
	15	Handling the FPAA project environment 2
Teaching methods (on-site classes)	L	Information lecture with multimedia presentation
	LC	Laboratory experiments
	-	
	-	
Teaching methods (online classes)	L	
	-	
	-	
	-	
Forms of crediting	L	Written final test with multiple-choice questions
	LC	Evaluation of reports, assessment of ongoing progress in work
	-	
	-	
Conditions of crediting	L	Achieve at least 50 percent positive responses. Positive rating values distributed proportionally in the range from 51% to 100%.
	LC	Attendance to the classes; positive grades of the reports. Final grade is the arithmetic mean of partial grades.
	-	
	-	

Outcome symbols	**Expected learning outcomes**	**Expected learning outcomes defined for the field of study**		
		Knowlegde	Skills	Social competence
	Knowledge: the student knows and understands			
E1	the architecture of analog matrices, C-switched circuits, and analog circuit digitization components;			
E2	the properties and basic functions of design tools and the handling mechanisms of analog matrices and ADA circuits.			
	Skills: the student can			
E3	use a computer-aided design system for analog-digital and digital circuits;			
E4	select and use the proper components and circuits for digitization and implementation of feedback in analog circuits.			
	Social competence: the student is ready to			
E5	self-assess their own and group projects.			

Outcome symbols	**Methods of verification of learning outcomes**	**Course form subject to verification**
E1	Test on lecture content	L
E2	Test on lecture content	L
E3	Preparation of student reports, exercise completion rate	LC
E4	Preparation of student reports, exercise completion rate	LC
E5	Observation of students work on exercises	LC

Basic references	1	Moschytz, George S: Analog Circuit Theory and Filter Design in the Digital World: With an Introduction to the Morphological Method for Creative Solutions and Design, Springer, 2019.
	2	Benedetto, John J Ferreira, Paulo J.S.G.: Modern Sampling Theory: Mathematics and Applications, Birkhauser, 2012.
	3	Gulak G., Chua L., Rodriguez-Vazques A., Pierzchala E..: Field Programmable Analog Arrays, Springer, 2013.
	4	Serra H.A., Nuno P.: Design of Switched-Capacitor Filter Circuits using Low Gain Amplifiers, Springer, 2015.
	5	Gay, Warren: Raspberry Pi Hardware Reference, Berkeley, 2014.
Supplementary references	1	Plassche, Rudy J. van de: Integrated Analog-To-Digital and Digital-To-Analog Converters, Springer, 2010.
	2	Johan Sansen, Willy M.C: Analog Circuit Design: High-Speed Analog-to-Digital Converters, Mixed Signal Design; PLLs and Synthesizers, Springer 2013.
	3	Gay, Warren: SPI Bus, Advanced Raspberry Pi, Apress L. P., 2018.
	4	Hasler J.: Large-Scale Field-Programmable Analog Arrays, Procedings of the IEEE, 2019.
	5	Okika Technologies.: OTC24000 Development Board Users Manual, 2016.

Course coordinator	Marian Gilewski, Ph.D. Eng.	**Date:**	21.03.2025