COURSE SPECIFICATION

Course code	full-time programme:	**M#2-S2-ME-EM-111**
	part-time programme:	
Course title in Polish	**Szybkie prototypowanie sterowania i symulacje hardware in the loop**	
Course title in English	**Rapid Control Prototyping and Hardware-in-the-Loop Simulation**	
Valid from (academic year)	**2024/2025**	

GENERAL INFORMATION

Programme of study	**MECHANICAL ENGINEERING**
Level of qualification	**second-cycle**
Type of education	**academic**
Mode of study	**full-time programme**
Specialism	**Machine Operation and Maintenance**
Department responsible	**Department of Mechatronics and Weapons Engineering**
Course leader	**dr hab. Jakub Takosoglu, prof. PŚk**
Approved by	**dr hab. Jakub Takosoglu, prof. PŚk, Dean of the Faculty of Mechatronics and Mechanical Engineering**

COURSE OVERVIEW

Course type		**specialism-related**
Course status		**compulsory**
Language of instruction		**English**
Semester of delivery	full-time programme	**Semester I**
	part-time programme	**Semester I**
Pre-requisites		
Examination required (YES/NO)		**NO**
ECTS value		**3**

Mode of instruction		**lecture**	**class**	**laboratory**	**project**	**seminar**
No. of hours per semester	full-time programme	**15**		**15**	**15**	
	part-time programme					

LEARNING OUTCOMES

Category of outcome	Outcome code	Course learning outcomes	Corresponding programme outcome code
Knowledge	W01	The student has structured advanced knowledge in the field of control theory, control objects, knows the technology of rapid control prototyping and hardware in the loop simulations, knows the synthesis of control algorithms supporting the solution of engineering problems related to the control of processes in mechanical engineering.	MiBM2_W03 MiBM2_W09
	W02	The student has structured advanced knowledge in the field of mechatronics, control of electric, pneumatic and hydraulic drives, has practical knowledge in the field of operation and safety of devices used in industry, including detailed knowledge of the design of control systems in mechanical engineering.	MiBM2_W07
Skills	U01	The student is able to consciously use computer software and specialist technical software in the area of mechanical engineering in the design of control systems and control objects, is able to apply rapid control prototyping technology and hardware in the loop simulations.	MiBM2_U08 MiBM2_U10
	U02	The student is able to work in a team, is able to organize and configure a laboratory stand in accordance with guidelines, is able to prepare a schedule for conducting laboratory tests.	MiBM2_U15
Competence	K01	The student is ready to critically evaluate his/her knowledge and the possibilities of acquiring new information in the field of designing control systems with PLC controllers in the field of mechanical engineering.	MiBM2_K01

COURSE CONTENT

Mode of instruction	Topics covered
lecture	Basic definitions of control rapid prototyping RCP techniques and hardware in the loop simulation HIL techniques. Real-time systems: dSpace, xPC Target. RCP system control system-real object. HIL system controller-virtual object. Examples of solutions.
laboratory	Basics of using the SIMULINK software. Basics of using the xPC Target and dSpace real-time systems. Getting to know the xPC Target and dSpace hardware platforms. Fuzzy control system for an electropneumatic servo drive. Control system for the rotational speed of a DC motor. Automatic temperature control system for a virtual object using a real controller.
project	Students in groups are tasked with designing a control system based on the rapid control prototyping technique or designing a virtual object controlled by a real controller based on the hardware in the loop simulation technique. The project includes the following activities: • Development of a conceptual model. • Selection of components. • Simulation testing of the designed systems. • Creation of the designed system in the laboratory. • Starting the system and testing it in laboratory conditions. • Analysis of the obtained results and conclusions. • Preparation of technical documentation.

ASSESSMENT METHODS

Outcome code	Methods of assessment					
	Oral examination	Written examination	Test	Project	Report	Other
W01			X			
W02			X			
U01			X	X	X	X
U02			X	X	X	X
K01						X

ASSESSMENT TYPE AND CRITERIA

Mode of instruction	Assessment type	Assessment criteria
lecture	non-examination assessment	Positive completion of the final test. Obtaining at least 50% of the points.
laboratory	non-examination assessment	Positive passing of tests and reports from the laboratories. The final grade is an arithmetic mean.
project	non-examination assessment	Project preparation and its positive defense.

OVERALL STUDENT WORKLOAD

ECTS weighting												
No.	Activity type	Student workload										Unit
		full-time programme					part-time programme					
1.	Scheduled contact hours	L	C	Lb	P	S	L	C	Lb	P	S	h
		15		**15**	**15**							
2.	Other contact hours (office hours, examination)	**2**		**2**	**2**							h
3.	**Total number of contact hours**	**51**										h
4.	**Number of ECTS credits for contact hours**	**2,0**										ECTS
5.	**Number of independent study hours**	**24**										h
6.	**Number of ECTS credits for independent study hours**	**1,0**										ECTS
7.	**Number of practical hours**	**50**										h
8.	**Number of ECTS credits for practical hours**	**2,0**										ECTS
9.	**Total study time**	**75**										h
10.	**ECTS credits for the course** *1 ECTS credit = 25-30 hours of study time*	**3**										ECTS

READING LIST

1. Levent Güvenç; Bilin Aksun-Güvenç; Burak Demirel; Mümin Tolga Emirler: Control of Mechatronic Systems, The Institution of Engineering and Technology, 2017.

2. Dirk A., Bollig A.: Rapid Control Prototyping. Methoden und Anwendungen, Institut für Regelungstechnik, RWTH Aachen, Aachen, 2006.
3. Frank W. Liou: Rapid Prototyping And Engineering Applications: A Toolbox for Prototype Development, CRC Pr I Llc, 2007.
4. Takosoglu J., Dindorf R., Laski P.: Rapid prototyping of fuzzy controller pneumatic servo-system, International Journal of Advanced Manufacturing Technology, Springer London Ltd, 2009.
5. www.mathworks.com
6. www.speedgoat.com
7. www.dspace.com