

COURSE DESCRIPTION CARD

BIALYSTOK UNIVERSITY OF TECHNOLOGY							Faculty of Electrical Engineering		
Field of study	Erasmus program						Level and form of study	Bachelor Level; Master Level	
A group of modules /specialty							Education profile	general	
Course name	Fundamentals of Robotics: Design and Motion Control						Course code	IS-FEE-10088S	
							Course type	elective	
Course form(s) and number of hours	L	C	LC	P	SW	FW	S	Semester	Summer
	15	5			10			ECTS credits	3
The programme is valid from	2024/2025								
Introductory courses									
Course objectives	Introduction to fundamental knowledge related to robotics, including the construction, design, and application of robots and their components. Kinematics and dynamics of manipulators. Introduction to programming industrial robots.								
Framework programme content	Lecture: Classification of robots, kinematic structures, concepts in the theory of machines and mechanisms. Forward and inverse kinematics problems. Denavit-Hartenberg notation (D-H). Graphical methods in kinematics. Design of the kinematic chain of a robot and end-effectors. Introduction to modeling the dynamics of multibody systems. Moments of inertia of a rigid body. Manipulator Jacobians. Trajectory planning for manipulator motion. Sensors and actuators used in robots. Vision systems, image recognition methods as elements of robot control systems. Types of mechanical transmissions used in the construction of robot arms. Basics of programming, programming languages, and program structures. Classes: Practical modeling of the kinematics and dynamics of a selected multibody mechanism - analytically. Specialized workshop: Kinematics and dynamics analysis of a selected manipulator structure using a chosen CAD/CAE tool. Stiffness analysis of the kinematic chain under static and dynamic loads. Modal analysis of the developed structure and optimization of the kinematic chain. Programming the motion of real industrial manipulators for selected industrial tasks.								
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						15	15	15
	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						12		
	preparation for practical classes						30		30
	Total number of hours:						75	33	47
Total number of ECTS credits:						3	1,3	1,9	
Expected discipline learning outcomes							Knowledge	Skills	Social competence
Objectives and framework content prepared by	Ph.D., Eng. Roman Trochimczuk						Date:		
Implementation in the academic year	2024/2025								
Programme content	Lecture								
	1	Classification of robots, kinematic structures, concepts in the theory of machines and mechanisms. Parameters of industrial robots.							
	2								
	3	Forward and inverse kinematics problems. Denavit-Hartenberg notation (D-H notation).							
	4								
	5	Design of the kinematic chain of a robot and end-effectors.							
	6								
	7	Introduction to modeling the dynamics of multibody systems. Moments of inertia of a rigid body.							
	8								
	9	Manipulator Jacobians. Trajectory planning for manipulator motion.							
	10								
	11	Sensors and actuators used in robots. Vision systems, image recognition methods as elements of robot control systems. Types of mechanical transmissions used in the construction of robot arms.							
	12								
	13	Basics of programming, programming languages, and program structures.							
	14								
	15	Concluding sessions. Passing the lectures.							
	Classes								
	1	Modeling of the kinematics of selected structure of kinematic open chain using D-H notation.							
	2								
	3	Modeling of the dynamics manipulator selected structure with rigid links.							
	4								
	5	Concluding sessions. Passing the classes.							
	Specialist workshop								
	1	Introducing the laboratory stand with robots and computer workstation with specialised engineering software.							
	2								
	3	Kinematics and dynamics analysis of a selected manipulator structure using a chosen CAD/CAE tool.							
	4	Stiffness analysis of the kinematic chain under static and dynamic loads. Modal analysis of the developed structure and optimization of the kinematic chain							
5									
6	Programming the motion of real industrial manipulators for selected industrial tasks - part I								
7									
8	Programming the motion of real industrial manipulators for selected industrial tasks - part II								
9									
10	Concluding sessions. Passing the scecialist workshop.								
L	Lecture on issues: informational lecture: lecture with multimedia presentation: use of a computer with software.								

Teaching methods (on-site classes)	C	Subject exercises - practical tasks method
	SW	Practical sessions at computers with engineering software; implementation of the assumed scenario in a specialized workshop with real industrial robot.
Teaching methods (online classes)	-	
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	-	
Forms of crediting	L	Written assessment with open-ended questions.
	C	Preparation of a report.
	SW	Preparation of a report.
Conditions of crediting	L	Assessment of responses to open-ended questions in a written exam verifying learning outcomes.
	C	Evaluation of reports, assessment of ongoing progress in work, discussions, and participation in classes.
	SW	Evaluation of reports, assessment of ongoing progress in work, discussions, and participation in classes.

Outcome symbols	Expected learning outcomes	Expected learning outcomes defined for the field of study		
		Knowledge	Skills	Social competence
Knowledge: the student knows and understands				
E1	the basic terms related to the theory of machines and mechanisms, robot and robotics			
E2	can define and know the principle of operation of the different components of a robot			
E3	knows the methods and tools for programming a robot			
Skills: the student can				
E4	is able to determine the D-H parameters necessary to solve robot or manipulator kinematics tasks			
E5	can determine the basic dynamics of the manipulator mechanism			
Social competence: the student is ready to				
E6	can, with due regard for health and safety regulations, operate and program a selected industrial manipulator			
Outcome symbols	Methods of verification of learning outcomes	Course form subject to verification		
E1	written assessment	L		
E2	written assessment	L		
E3	written assessment; preparation of reports for the specialized workshop	L,SW		
E4	preparation of reports to individual task	C		
E5	preparation of reports to individual task	C		
E6	preparation of reports for the specialized workshop	SW		
Basic references	1 Craig J. J., Wprowadzenie do robotyki. Mechanika i sterowanie. WNT, Warszawa, 2003.			
	2 Spong M. W., Vidyasagar M.: Dynamika i sterowanie robotów, WNT, Warszawa, 1997.			
	3 Szkodny T., Zbiór zadań z podstaw robotyki. WPS, Gliwice, 2013.			
	4 Zdanowicz R., Podstawy robotyki. WPS, Gliwice, 2011.			
	5 Honczarenko J., Roboty przemysłowe: budowa i zastosowanie. WNT, Warszawa, 2010.			
Supplementary references	1 Wittbrodt E., Adamiec-Wójcik I., Wojciech S. Dynamics of flexible multibody systems: rigid finite element method. Springer Science & Business Media, 2007.			
	2 Adamiec-Wójcik I., Modelling dynamics of multibody systems using homogenous transformations. Wydawnictwo ATH, 2003.			
	3 Morecki A., Knapczyk J., Podstawy robotyki. WNT, Warszawa, 1999.			
	4 Buratowski T., Postawy robotyki. Uczelniane Wydawnictwa Naukowo-Techniczne AGH, Kraków 2006.			
	5 Kozłowski K., Dutkiewicz P., Wróblewski W., Modelowanie i sterowanie robotów. PWN, Warszawa, 2003.			
Course coordinator	Ph.D., Eng. Roman Trochimczuk	Date:	20.02.2024	