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** 15 5 10	**Semester**	**Summer**
		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 2	Classification of robots, kinematic structures, concepts in the theory of machines and mechanisms. Parameters of industrial robots.
3 4	Forward and inverse kinematics problems. Denavit-Hartenberg notation (D-H notation).
5 6	Design of the kinematic chain of a robot and end-effectors.
7 8	Introduction to modeling the dynamics of multibody systems. Moments of inertia of a rigid body.
9 10	Manipulator Jacobians. Trajectory planning for manipulator motion.
11 12	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.
13 14	Basics of programming, programming languages, and program structures.
15	Concluding sessions. Passing the lectures.
	Classes
1 2	Modeling of the kinematics of selected structure of kinematic open chain using D-H notation.
3 4	Modeling of the dynamics manipulator selected structure with rigid links.
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 5	Stiffness analysis of the kinematic chain under static and dynamic loads. Modal analysis of the developed structure and optimization of the kinematic chain
6 7	Programming the motion of real industrial manipulators for selected industrial tasks - part I
8 9	Programming the motion of real industrial manipulators for selected industrial tasks - part II
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)	-	
	-	
	-	
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**		
		Knowlegde	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 progamming 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., Wprowdzenie 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. WPŚ, Gliwice, 2013.*
	4	*Zdanowicz R., Podstawy robotyki. WPŚ, 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*