GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Modelling of robots and manipulators , PG_00042732						
Field of study	Mechatronics						
Date of commencement of studies	February 2023		Academic year of realisation of subject	2023/2024			
Education level	second-cycle studies		Subject group				
Mode of study	Full-time studies		Mode of delivery	at the university			
Year of study	1		Language of instruction	Polish			
Semester of study	2		ECTS credits	2.0			
Learning profile	general academic profile		Assessment form	assessment			
Conducting unit	Institute of Mechanics and Machine Design -> Faculty of Mechanical Engineering and Ship Technology						
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Michał Mazur					
	Teachers	dr inż. Michał Mazur dr inż. Wiktor Sieklicki					
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	15.0	0.0	0.0	30
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours	Self-study		SUM
	Number of study hours	30		0.0	0.0		30
Subject objectives	Expanding knowledge about modeling of robots and manipulators. The perception of robots as a mechatronic system. Some specific issues relating to the actors, sensors and control systems.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W06] has detailed, supported by the theory knowledge in terms of mechatronic design, mechatronic systems and machines, devices and process where they are used	Students have theoretically founded knowledge related to the issues of mechatronic design and mechatronic systems in the field of robots.	[SW1] Assessment of factual knowledge
[K7_W01] has extended knowledge in terms of selected areas of mathematics, including discrete and applied mathematics, optimisation methods, mathematical and numerical methods essential for: 1) modelling and analysis of nonstationary mechatronics, continuous and discrete time systems as well as physical phenomena; 2) description and analysis of mechatronic systems that include programmable devices 3) description and analysis of signal processing algorithms 4) synthesis of non-stationary mechatronic systems	Students understand the necessity of using discrete modeling techniques for robot design and operation.	[SW1] Assessment of factual knowledge
[K7_W10] knows development trends and most important new achievements in technical sciences and science disciplines: Mechanical Engineering, Automation, Electronics and Electrical Engineering and related: Informatics and Materials Engineering	Students have knowledge about development trends and the most important new achievements in the field of robots.	[SW1] Assessment of factual knowledge
[K7_U04] is able to utilise known methods and mathematical models, as well as computer simulations for analysis and evaluation of non-stationary continuous and discrete mechatronic systems and processes	Students know the available virtual prototyping tools used to design robots.	[SU4] Assessment of ability to use methods and tools

Subject contents

LECTURE: 1 Introduction 2 Modern trends in the development of two industrial robots 3 Sensors 4 Signal Conditioning 5 Tactile and haptic sensors 6 Methods of localization of mobile robots 7 Effectors 8 Elements of power supply systems 9 Drive chain elements used in robots 10 Tools for robot programming and simulation

Laboratory: 1 Programming the tasks of a delta robot on the example of ABB IRB360, working with a belt feeder 2 Programming the tasks of the HC3a collaborative robot using the OnRobot vision system 3 Programming the movement of an industrial robot with coupling from a force sensor on the example of the Nachi NC04 robot 4. kinematics and dynamics of manipulator movements using the RobotAnalyzer program 5. Development of the manipulator's movement path for the implementation of a specific movement task in a simulation using the Nachi MZ04 manipulator available in the RoboDK 6 libraries. Operating the Nachi NC04 robot and programming its movement trajectories using the robot controller 7. Preparing the manipulator's movement path for the purpose of implementing a specific movement task of the ABB IRB360 robot using the RobotStudio program and a robot controller. 8. Operating the HCR-3a robot and preparing the manipulator's movement path for the purpose of implementing a specific robot movement task using direct learning

Prerequisites and co-requisites

Knowledge and experience in Industrial Robots and Manipulators (I-st level). Knowledge and experience in Informatics (I-st level). Knowledge and experience in Mechatronic design (I-st level).

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Team projects	50.0%	40.0%
Midterm colloquium	50.0%	60.0%

Recommended reading

Basic literature	Craig J., J., Wprowadzenie do robotyki. Mechanika i sterowanie, WNT, Warszawa 1993 Honczarenko J., Roboty przemysłowe. Budowa i zastosowanie, WNT, Warszawa 2002 Jarzębowska E., Podstawy dynamiki mechanizmów i manipulatorów, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 1998 Morecki A., Knapczyk J., Podstawy robotyki. Teoria i elementy manipulatorów i robotów, WNT, Warszawa 1993 Morecki A., Knapczyk J., Kędzior K., Teoria mechanizmów i manipulatorów, WNT, Warszawa 2002 Vidyasagar M., Spong Mark W.: Dynamika i sterowanie robotów. WNT, Warszawa 1997

	Supplementary literature	Dulęba I., Metody i algorytmy planowania ruchu robotów mobilnych i manipulacyjnych, Akademicka Oficyna Wydawnicza EXIT, Warszawa 2001 Giergiel M. J., Hendzel Z., Żylski W.: Modelowanie i sterowanie mobilnych robotów kołowych. PWN, Warszawa 2002 Tchoń K., Mazur A., Dulęba I., Hossa R., Muszyński R.: Manipulatory i Roboty Mobilne. Modele, planowanie ruchu, sterowanie. Warszawa: Akademicka Oficyna Wydawnicza PLJ 2000
	eResources addresses	Adresy na platformie eNauczanie:
Example issues/ example questions/ tasks being completed	What is a sensor? Advantages and disadvantages of digital sensors? Advantages and disadvantages of analog sensors? Discuss conditioning.Haptic systems Robots development trends Advantages and disadvantages of ultrasonic sensors for distance measurement List the location methods Techniques for measuring distance Mechatronic system of robots Advantages and disadvantages of FPGA What is High Level Synthesis? Advantages and disadvantages of monolithic architecture Advantages and disadvantages of distributed architecture Robust programming - fault detection techniques Application of real-time systems in robot control What is SLAM? What do we use quaternions for? Discuss Spherical Linear Interpolation Applications of dual quaternions What is ROS? Discuss MoveIT Discuss 2D Navigation in a ROS environment Discuss the control of the qaudrocopeter What is Zero Moment Point?	
Work placement	Not applicable	