Bialystok University of Technology
Faculty of Electrical Engineering

Field of study	**Industry Digitization**							Degree level and programme type	**full-time Bachelor's degree**
Specjalization / diploma path	**common subject**							Study profile	**general academic**
Course name	**Robotization of industrial processes**							Course code	**CP1S06001**
								Course type	**obligatory**
Forms and number of hours of educational ectivities	L	C	LC	P	SW	FW	S	Semester	**6**
	15				**30**			No. of ECTS credits	**4**
Entry requirements	Fundamentals of robotics, Autonomous robots, Industrial robots								
Course objectives	Introduction to the use of robots and the structure and operation of robotic production systems. Acquainting with the procedures of designing robotic solutions based on the analysis of existing solutions. The use of CAD programs for the implementation of the technical design. The use of multimedia techniques to visualize the operation of a technical solution.								
Course content	Lecture: Design of a robotic system. Production and service processes. Collection and commissioning of a new robotic system. End effectors: typical designs, drives, interface with a robot arm and their applications. Practical applications of robots: handling, assembly, painting, welding, cutting materials, dispensing sealants, foams and adhesives, testing and inspection, services, medicine. Possible applications of the robot; robot selection; products, scenarios and visions of robotic systems in industry and services. Robotic production systems. Non-technical aspects of robots application: economic and organizational, social, ethical. The robotic system, its components and configurations. Transport in close proximity to the robot. Robot system control. Specialistic workshop: Development of a robotic system concept with a selected service robot based on the analysis of existing solutions. Determining the requirements for major functions and relevant performance data. Description of the environment of use. Identification of key elements and market potential. Estimate design costs, development expenditure, and innovative aspects of bringing a solution to market in a CAD environment.								
Teaching methods	Informative-problem lecture; Specialization workshop;								
Assessment method	Lecture: one test Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop								

Symbol of learning outcome	Learning outcomes	Reference to the learning outcomes for the field of study
	Knowledge: the graduate knows and understands	
LO1	basic concepts of robotic production systems	CP1_W03
LO2	configurations and design methods of robotic systems	CP1_W05

LO2	configurations and design methods of robotic systems	
LO3	structure and operating principles of basic end effectors and the way of their interfacing with a robot arm	CP1_W12
	Skills: the graduate is able to	
LO4	use CAD software and selected multimedia tools to design a given technical system	CP1_U04 CP1_U06 CP1_U09
LO5	analyze existing technical solutions, identify technical problems and create guidelines for his/her own designs of robotic systems	CP1_U06
	Social competences: the graduate is ready to	
LO7	think and act in a creative and enterprising way	CP1_K04
LO8	self-education and improvement of qualifications, use of own knowledge and experts opinions in order to solve various problems	CP1_K01

Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	Lecture: one test;	W
LO2	Lecture: one test;	W
LO3	Lecture: one test;	W
LO4	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO5	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO7	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO8	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps

Student workload (in hours)		No. of hours
Calculation	Lecture attendance	15
	Workshop attendance	30
	Preparation for lecture test(s)	19
	Preparation for specialistic workshop	24
	Preparation for workshop completion	7
	Participation in teacher-student sessions related to the module subject	5
	TOTAL	100

Quantitative indicators	Hours	ECTS
Student workload - activities that require direct teacher participation	50	2
Student workload - practical activities	66	2,6

Basic references	1. Gawrysiak M., Wykłady Robotyzacja 2004, (dostępne w postaci plików pdf). 2. Zdanowicz R., Robotyzacja procesów wytwarzania. Wydawnictwo Politechniki Śląskiej, Gliwice 2007. 3. Zdanowicz R., Robotyzacja dyskretnych procesów produkcyjnych. Wydawnictwo Politechniki Śląskiej, Gliwice 2011.

	4. Kost G., Łebkowski P., Węsierski Ł., Automatyzacja i robotyzacja procesów produkcyjnych. Wydawnictwo PWE, 2013 5. Kaczmarek W. Panasiuk J., Robotyzacja procesów produkcyjnych. Wydawnictwo Naukowe PWN, 2017.	
Supplementary references	1. Bazy online czasopism naukowych i wydawnictw naukowych z Biblioteki Politechniki Białostockiej. 2. Materiały z Internetu ze wskazaniem na biblioteki cyfrowe dotyczące najnowszych rozwiązań z dziedziny robotyki, robotyzacji, automatyki i mechatroniki, np. www.intechopen.com, bazy online czasopism naukowych z bibliotek internetowych Web of Science, IEEE, SCOPUS, GOOGLE SCHOLAR, GOOGLE PATENTS itp.	
Organisational unit conducting the course	Department of Automatic Control and Robotics	Date of issuing the programme
Author of the programme	dr inż. Roman Trochimczuk	2022-06-07

Bialystok University of Technology
Faculty of Electrical Engineering

Field of study	**Industry Digitization**							Degree level and programme type	**full-time Bachelor's degree**
Specjalization / diploma path	**common subject**							Study profile	**general academic**
Course name	**Algorithms of artificial intelligence 1**							Course code	**CP1S06002**
								Course type	**elective**
Forms and number of hours of educational ectivities	L	C	LC	P	SW	FW	S	Semester	**6**
	15				**30**			No. of ECTS credits	**4**
Entry requirements	Digital signal processing, Python programming 1, Python programming 2								
Course objectives	Getting to know the basic concepts of artificial intelligence. Characteristics, description and application of artificial neural networks. Familiarization with machine learning techniques. Acquiring knowledge of the performance characteristics and applications of genetic algorithms. Acquisition of skills in the field of design and teaching of neural networks. Implementation of selected genetic algorithms.								
Course content	Lecture: Introduction to artificial intelligence, historical outline, basic concepts, achievements and applications to date. Artificial neural networks: structure, division, basic models of neurons, learning algorithms. Evolutionary algorithms: principle of operation, stages of evolution, parameters of evolution, evolution problems. Searching large databases. Specialistic workshop: Implementation of a neural network for the identification of object states and calibration of measurement signals. A genetic algorithm applied to the search for the optimal design of a simple electric vehicle. Application of the genetic algorithm to realize the autonomous gait of the bioinspired mechanism.								
Teaching methods	Informative-problem lecture; Specialization workshop;								
Assessment method	Lecture: exam Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop								

Symbol of learning outcome	Learning outcomes	Reference to the learning outcomes for the field of study
	Knowledge: the graduate knows and understands	
LO1	basic artificial intelligence algorithms	CP1_W01 CP1_W02 CP1_W08
LO2	structure and operating principles of artificial neural networks	CP1_W01 CP1_W02 CP1_W08
LO3	evolutionary algorithms	CP1_W08
	Skills: the graduate is able to	
LO4	carry out calculations with the use of artificial intelligence algorithms	CP1_U02 CP1_U10 CP1_U12

LO5	design the control law with the use of a selected method of artificial intelligence	CP1_U03 CP1_U06 CP1_U10
	Social competences: the graduate is ready to	
LO7	keep to principles of professional ethics while using artificial intelligence in engineering tasks	CP1_K02
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	Lecture: exam;	W
LO2	Lecture: exam;	W
LO3	Lecture: exam;	W
LO4	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO5	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO7	Lecture: exam; Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	W Ps
Student workload (in hours)		No. of hours
Calculation	Lecture attendance	15
	Workshop attendance	30
	Preparation for the lecture exam; participation in the exam	20
	Preparation for specialistic workshop	23
	Preparation for workshop completion	7
	Participation in teacher-student sessions related to the module subject	5
	TOTAL	100
Quantitative indicators		Hours / ECTS
Student workload - activities that require direct teacher participation		52 / 2,1
Student workload - practical activities		65 / 2,6
Basic references	1. Rudkowski L., Metody i techniki sztucznej inteligencji. Inteligencja obliczeniowa. PWN Warszawa 2005. 2. Osowski S., Sieci neuronowe do przetwarzania informacji. Oficyna Wydawnicza Politechniki Warszawskiej 2013. 3. Conway D., White M. J., Uczenie maszynowe dla programistów. Gliwice, Helion, 2015.	
Supplementary references	1. Russell S. J., Norvig P., Artificial intelligence - a modern approach (2nd Ed.), Prentice-Hall, 2001. 2. Krawiec K., Stefanowski J., Uczenie maszynowe i sieci neuronowe, Oficyna Wydawnicza Politechniki Poznańskiej, 2004. 3. Cichosz P., Systemy uczące się. Wydawnictwa Naukowo-Techniczne, Warszawa, 2000.	
Organisational unit conducting the course	Department of Automatic Control and Robotics	Date of issuing the programme
Author of the programme	dr inż. Sławomir Romaniuk	2022-06-07

Bialystok University of Technology
Faculty of Electrical Engineering

Field of study	**Industry Digitization**							Degree level and programme type	**full-time Bachelor's degree**
Specjalization / diploma path	**common subject**							Study profile	**general academic**
Course name	**Algorithms of intelligent controllers**							Course code	**CP1S06003**
								Course type	**elective**
Forms and number of hours of educational ectivities	L	C	LC	P	SW	FW	S	Semester	**6**
	15				**30**			No. of ECTS credits	**4**
Entry requirements	Digital signal processing, Python programming 1, Python programming 2								
Course objectives	Knowing and understanding the operation of intelligent controllers. Description, definition, characteristics and application of intelligent control systems. Defining and systematizing machine learning for use in intelligent control systems. Acquisition of skills in the use of artificial neural networks in the implementation of control of linear and non-linear objects. Application of fuzzy logic to control automation systems. The use of genetic algorithms for the implementation of control algorithms.								
Course content	Lecture: heoretical introduction in the field of intelligent controllers, historical outline, basic concepts, achievements to date, current applications and development direction. Machine learning: artificial intelligence in the implementation of control tasks - basic concepts, systematizing the division. Examples of the use of machine learning in industry. Fuzzy algorithms: fuzzy logic, fuzzy control. Application of artificial intelligence methods in controlling linear and non-linear objects as well as objects with parametric characteristics variable in time. Examples of difficult to describe objects. Specialistic workshop: ANN implementation for the control of a non-linear object. Application of the genetic algorithm for the automatic selection of the PID controller settings and for the optimization of the parameters of the object control law. Implementation of the law of controlling an object that changes in time with the use of fuzzy logic.								
Teaching methods	Informative-problem lecture; Specialization workshop;								
Assessment method	Lecture: exam Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop								

Symbol of learning outcome	Learning outcomes	Reference to the learning outcomes for the field of study
	Knowledge: the graduate knows and understands	
LO1	basic algorithms of intelligent controllers	CP1_W01 CP1_W02 CP1_W08
LO2	applications of artificial neural networks in control systems	CP1_W01 CP1_W02 CP1_W08
LO3	methods of fuzzy control implementation	CP1_W02 CP1_W08

LO3	methods of fuzzy control implementation	
	Skills: the graduate is able to	
LO4	develop control algorithm an intelligent controller	CP1_U02 CP1_U07 CP1_U08
LO5	design the control law with the use of a selected method of artificial intelligence	CP1_U02 CP1_U07
	Social competences: the graduate is ready to	
LO7	keep to principles of professional ethics while programming algorithms of intelligent controllers	CP1_K02

Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	Lecture: exam;	W
LO2	Lecture: exam;	W
LO3	Lecture: exam; Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	W Ps
LO4	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO5	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO7	Lecture: exam; Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	W Ps

Student workload (in hours)		No. of hours
Calculation	Lecture attendance	15
	Workshop attendance	30
	Preparation for the lecture exam; participation in the exam	20
	Preparation for specialistic workshop	23
	Preparation for workshop completion	7
	Participation in teacher-student sessions related to the module subject	5
	TOTAL	100

Quantitative indicators	Hours	ECTS
Student workload - activities that require direct teacher participation	52	2,1
Student workload - practical activities	65	2,6

Basic references	1. Rudkowski L., Metody i techniki sztucznej inteligencji. Inteligencja obliczeniowa. PWN Warszawa 2005. 2. Osowski S., Sieci neuronowe do przetwarzania informacji. Oficyna Wydawnicza Politechniki Warszawskiej 2013. 3. Conway D., White M. J., Uczenie maszynowe dla programistów. Gliwice, Helion, 2015.
Supplementary references	1. Krawiec K., Stefanowski J., Uczenie maszynowe i sieci neuronowe, Oficyna Wydawnicza Politechniki Poznańskiej, 2004. 2. Cichosz P., Systemy uczące się. Wydawnictwa Naukowo-Techniczne, Warszawa, 2000.
Organisational unit conducting the course	Department of Automatic Control and Robotics — Date of issuing the programme

Author of the programme	dr inż. Sławomir Romaniuk	2022-06-07

Bialystok University of Technology
Faculty of Electrical Engineering

Field of study	**Industry Digitization**							Degree level and programme type	**full-time Bachelor's degree**
Specjalization / diploma path	**common subject**							Study profile	**general academic**
Course name	**Image processing algorithms**							Course code	**CP1S06004**
								Course type	**elective**
Forms and number of hours of educational ectivities	L	C	LC	P	SW	FW	S	Semester	**6**
	30				**30**			No. of ECTS credits	**6**
Entry requirements	Digital signal processing								
Course objectives	Provide basic information on image processing and compression. Acquisition of the skills of image content analysis, extracting the desired image features, forming the appropriate image form depending on possible applications.								
Course content	Lecture: Image formation and image perception by humans, context-free operations and changing image parameters (brightness, saturation, contrast), image processing in frequency domain (spatial FFT transformation) and digital image filtering, mathematical morphology, image reduction, re-sampling and change of image resolution, reduction of correlated and uncorrelated noise, object recognition, image compression. Specialistic workshop: Contextless and contextual operations on images, morphological operations, image transformations, image resolution change, noise reduction procedures, object recognition, image compression and coding.								
Teaching methods	Informative-problem lecture; Specialization workshop;								
Assessment method	Lecture: exam Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop								

Symbol of learning outcome	Learning outcomes	Reference to the learning outcomes for the field of study
	Knowledge: the graduate knows and understands	
LO1	selected methods of signal/image analysis/processing	CP1_W09
	Skills: the graduate is able to	
LO4	acquire knowledge from literature, databases and other sources, also in a foreign language; integrate the obtained information, interpret it, draw conclusions and formulate and justify opinions	CP1_U01
LO5	use knowledge from various fields of science to analyze, formulate	CP1_U02

LO5	and solve complex technical problems	
LO6	plan his/her own development; work individually and in a team; estimate the time needed to complete the task; develop a work schedule and carry out this schedule while meeting the adopted deadlines	CP1_U03
	Social competences: the graduate is ready to	
LO7	critical assessment of knowledge, self-education and improvement of qualifications, use of own knowledge and experts opinions in order to solve various problems	CP1_K01

Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	Lecture: exam;	W
LO4	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO5	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO6	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO7	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps

Student workload (in hours)		No. of hours
Calculation	Lecture attendance	30
	Workshop attendance	30
	Preparation for the lecture exam; participation in the exam	33
	Preparation for specialistic workshop	40
	Preparation for workshop completion	12
	Participation in teacher-student sessions related to the module subject	5
	TOTAL	150

Quantitative indicators	Hours	ECTS
Student workload - activities that require direct teacher participation	67	2,7
Student workload - practical activities	87	3,5

Basic references	1. Doros M., Przetwarzanie obrazów. Skrypt WSISIZ, Warszawa 2005. 2. Malina W., Smiatacz M., Cyfrowe przetwarzanie obrazów. Akademicka Oficyna Wydawnicza EXIT, Warszawa 2012. 3. Mokrzycki W. S., Wprowadzenie do przetwarzania informacji wizualnej I: Percepcja, akwizycja, wizualizacja. Akademicka Oficyna Wydawnicza Exit, Warszawa 2010. 4. Mokrzycki W. S., Wprowadzenie do przetwarzania informacji wizualnej II: Dyskretyzacja, operacje pikselowe, morfologiczne i przekształcenia obrazowe. Oficyna Wydawnicza EXIT, Warszawa 2012. 5. Wróbel Z., Koprowski R., Praktyka przetwarzania obrazów w programie Matlab. Oficyna Wydawnicza EXIT, Warszawa 2004.
	1. Gonzalez R. C., Woods R. E., Digital image processing. Prentice Hall, 2008.

Supplementary references	2. Tadeusiewicz R., Korohoda P., Komputerowa analiza i przetwarzanie obrazów. Społeczeństwo globalnej informacji. Wydawnictwo Fundacji Postępu Telekomunikacji, Kraków 1997. 3. Domański M., Obraz cyfrowy. WKŁ, Warszawa 2010. 4. Rafajłowicz E., Rafajłowicz W., Wstęp do przetwarzania obrazów przemysłowych. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2014.	
Organisational unit conducting the course	Department of Photonics, Electronics and Light Technology	Date of issuing the programme
Author of the programme	dr hab. inż. Ewa Świercz, prof. PB	2022-06-07

Bialystok University of Technology
Faculty of Electrical Engineering

Field of study	**Industry Digitization**							Degree level and programme type	**full-time Bachelor's degree**
Specjalization / diploma path	**common subject**							Study profile	**general academic**
Course name	**Objects recognition in industrial processes**							Course code	**CP1S06005**
								Course type	**elective**
Forms and number of hours of educational ectivities	L	C	LC	P	SW	FW	S	Semester	**6**
	30				**30**			No. of ECTS credits	**6**
Entry requirements	Digital signal processing								
Course objectives	Providing basic information on the recognition of industrial objects using imaging techniques. Understanding the methods of image acquisition, image correction, detection and identification of objects or defects based on a group of pixels. Acquiring the ability to analyze the image content, extract the desired image features that allow the assessment of objects in the images, classification of objects based on features, estimation of the location of the object using the system of vision cameras.								
Course content	Lecture: Image acquisition by camera and vision systems, human image perception, context-free operations and image parameter change (brightness, saturation, contrast), object detection and identification using segmentation, contour finding, image enhancement (spatial filtering, mathematical morphology), resampling and change of image resolution, noise reduction, detection and identification of objects or defects based on a group of pixels, classification of objects in an image, object position estimation. Specialistic workshop: Image analysis methods: context-free operations on images, contextual operations on images, image transformations improving the quality, changing image resolution. Morphological operations and their role in recognizing image objects. Selected transformations of feature extraction (SIFT, SURF and others) in the tasks of classification and recognition of objects in images.								
Teaching methods	Informative-problem lecture; Specialization workshop;								
Assessment method	Lecture: exam Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop								

Symbol of learning outcome	Learning outcomes	Reference to the learning outcomes for the field of study
	Knowledge: the graduate knows and understands	
LO1	selected methods of signal/image analysis/processing	CP1_W09
	Skills: the graduate is able to	
LO4	acquire knowledge from literature, databases and other sources, also in a foreign language; integrate the obtained information, interpret it	CP1_U01

LO4	in a foreign language, integrate the obtained information, interpret it, draw conclusions and formulate and justify opinions	
LO5	use knowledge from various fields of science to analyze, formulate and solve complex technical problems	CP1_U02
LO6	plan his/her own development; work individually and in a team; estimate the time needed to complete the task; develop a work schedule and carry out this schedule while meeting the adopted deadlines	CP1_U03
	Social competences: the graduate is ready to	
LO7	critical assessment of knowledge, self-education and improvement of qualifications, use of own knowledge and experts opinions in order to solve various problems	CP1_K01

Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	Lecture: exam;	W
LO4	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO5	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO6	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO7	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps

Student workload (in hours)		No. of hours
Calculation	Lecture attendance	30
	Workshop attendance	30
	Preparation for the lecture exam; participation in the exam	33
	Preparation for specialistic workshop	40
	Preparation for workshop completion	12
	Participation in teacher-student sessions related to the module subject	5
	TOTAL	150

Quantitative indicators	Hours	ECTS
Student workload - activities that require direct teacher participation	67	2,7
Student workload - practical activities	87	3,5

Basic references

1. Doros M., Przetwarzanie obrazów. Skrypt WSISIZ, Warszawa 2005.
2. Malina W., Smiatacz M., Cyfrowe przetwarzanie obrazów. Akademicka Oficyna Wydawnicza EXIT, Warszawa 2012.
3. Mokrzycki W. S., Wprowadzenie do przetwarzania informacji wizualnej I: Percepcja, akwizycja, wizualizacja. Akademicka Oficyna Wydawnicza Exit, Warszawa 2010.
4. Mokrzycki W. S., Wprowadzenie do przetwarzania informacji wizualnej II: Dyskretyzacja, operacje pikselowe, morfologiczne i przekształcenia obrazowe. Oficyna Wydawnicza EXIT, Warszawa 2012.

	5. Wróbel Z., Koprowski R., Praktyka przetwarzania obrazów w programie Matlab. Oficyna Wydawnicza EXIT, Warszawa 2004.	
Supplementary references	1. Gonzalez R. C., Woods R. E., Digital image processing, Prentice Hall, 2008. 2. Tadeusiewicz R., Korohoda P., Komputerowa analiza i przetwarzanie obrazów. Społeczeństwo globalnej informacji. Wydawnictwo Fundacji Postępu Telekomunikacji, Kraków 1997. 3. Domański M., Obraz cyfrowy. WKŁ, Warszawa 2010. 4. Rafajłowicz E., Rafajłowicz W., Wstęp do przetwarzania obrazów przemysłowych. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2014. 5. Kwiatkowski W.: Metody automatycznego rozpoznawania wzorców, BEL Studio, 2007.	
Organisational unit conducting the course	Department of Photonics, Electronics and Light Technology	Date of issuing the programme
Author of the programme	dr hab. inż. Ewa Świercz, prof. PB	2022-06-07

Bialystok University of Technology
Faculty of Electrical Engineering

Field of study	**Industry Digitization**							Degree level and programme type	**full-time Bachelor's degree**
Specjalization / diploma path	**common subject**							Study profile	**general academic**
Course name	**Interim team project**							Course code	**CP1S06006**
								Course type	**elective**
Forms and number of hours of educational ectivities	L	C	LC	P	SW	FW	S	Semester	**6**
				30				No. of ECTS credits	**3**
Entry requirements	-								
Course objectives	Expanding knowledge in the field of digitization of industrial processes through independent study of specialist literature. Acquisition of the ability to solve complex technical problems, consisting in the digitization of selected industrial processes using methods and tools learned during studies and acquired through independent analysis of application examples and studying literature. Developing teamwork skills in solving a given engineering problem.								
Course content	Project classes: Development of a project for the digitization of a selected industrial process. The division of tasks and the definition of rules of cooperation between the members of the project team. Analysis of the literature in terms of technologies and solutions known and used in a given process. Description of the process, determination of the required production resources, measurement and control signals, material and energy flows. Process virtualization: developing a digital twin. Cloud processing of measurement and control data: selection of network technology and data transmission security, design of a cloud database, processing algorithms for large data sets. Selection and programming of robots and cooperating manipulators. Estimating the impact of the proposed solution on the social and economic environment. Presentation, discussion and defense of the completed project in the forum of the student group.								
Teaching methods	Project classes;								
Assessment method	Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes								

Symbol of learning outcome	Learning outcomes	Reference to the learning outcomes for the field of study
	Knowledge: the graduate knows and understands	
LO1	selected industrial processes as the basis for their digitization	CP1_W03
LO2	principles, methods and tools used in digitization of industrial processes	CP1_W04 CP1_W05 CP1_W08 CP1_W09
LO3	non-technical aspects of engineering activity	CP1_W11

LO3	non-technical aspects of engineering activity	
	Skills: the graduate is able to	
LO4	select appropriate tools and methods to digitize a given industrial process	CP1_U06 CP1_U07 CP1_U08 CP1_U09 CP1_U10
LO5	obtain information from various sources, integrate and interpret them, draw conclusions and apply in his/her engineering practice	CP1_U01
LO6	work in a team during the implementation of an engineering project; prepare and present a short presentation on the results of this work	CP1_U03 CP1_U04
	Social competences: the graduate is ready to	
LO7	creative approach to the implementation of the design task	CP1_K04
LO8	use the acquired own knowledge and the knowledge of people with greater engineering experience to solve complex technical problems	CP1_K01

Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	P
LO2	Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	P
LO3	Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	P
LO4	Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	P
LO5	Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	P
LO6	Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	P
LO7	Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	P
LO8	Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	P

Student workload (in hours)		No. of hours
Calculation	Project attendance	30
	Preparation for project classes	21
	Working on projects (including preparation of presentations)	12
	Preparation for projects completion	7
	Participation in teacher-student sessions related to the module subject	5
	TOTAL	75

Quantitative indicators	Hours	ECTS
Student workload - activities that require direct teacher participation	35	1,4

Student workload - practical activities		75	3
Basic references	1. Rudawska A., Student's team project experiences and their attitudes towards teamwork. Journal of Management and Business Administration. Central Europe, 25(1), 2017, 78-97. 2. Literatura techniczna z zakresu tematyki realizowanego projektu.		
Supplementary references	1. Smith K. A., Project management and teamwork. McGraw Hill, 2000. 2. Zarządzanie zespołem. PARP, Wschód Biznesu, 2014. https://www.wschodzimy.pl		
Organisational unit conducting the course	Department of Automatic Control and Robotics	Date of issuing the programme	
Author of the programme	dr hab. inż. Zbigniew Kulesza, prof. PB	2022-06-07	

Bialystok University of Technology
Faculty of Electrical Engineering

Field of study	**Industry Digitization**							Degree level and programme type	**full-time Bachelor's degree**
Specjalization / diploma path	**common subject**							Study profile	**general academic**
Course name	**Cloud databases**							Course code	**CP1S06007**
								Course type	**obligatory**
Forms and number of hours of educational ectivities	L	C	LC	P	SW	FW	S	Semester	**6**
	15				**30**			No. of ECTS credits	**3**
Entry requirements	Database systems, Computer networks and wireless systems								
Course objectives	Acquainting with cloud databases. Acquisition of skills of their establishment, configuration and maintenance.								
Course content	Lecture: Cloud databases, introduction, cloud database solutions, elements that should run in the cloud, services and applications. Distributed databases. Cloud programming - cloud computing. Cloud services available, IaaS, SaaS, PaaS, artificial intelligence algorithms. Connection of a cloud database with IoT systems. Communication protocols used for connectivity with the cloud. Virtual machines. Models of implementing cloud databases, traditional model, DBaaS model. Advantages and disadvantages of a cloud database. Cloud database management methods. Autonomous cloud databases. Types of cloud databases and the transition to a multi-model database. Data security, system reliability, scalability. Moving a local database to the cloud. Specialistic workshop: Establishment and configuration of the IaaS platform. Virtual machine configuration, scaling. Maintaining the cloud database. Writing C language software for communication with cloud applications. Creation and configuration of a cloud database on an assumed virtual machine. Connection of the sensor system working in the Internet of Things model to the cloud database. Deploy system security components. Communication with the created cloud from stationary and mobile devices. Programming of applications in the cloud for data processing and analysis. Data visualization carried out directly in the cloud, on a stationary device and on a mobile device. Configuration of alarm algorithms. Establishing a distributed database.								
Teaching methods	Informative-problem lecture; Specialization workshop;								
Assessment method	Lecture: one test Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop								

Symbol of learning outcome	Learning outcomes	Reference to the learning outcomes for the field of study

	Knowledge: the graduate knows and understands	
LO1	selected concepts of cloud databases and cloud services	CP1_W01
LO2	architecture, functions, programming and applications of microprocessor systems used in the Internet of Things associated with cloud databases	CP1_W06
LO3	artificial intelligence algorithms used in cloud databases	CP1_W08
	Skills: the graduate is able to	
LO4	design a cloud database	CP1_U08
LO5	use IT tools in the field of visualization and virtualization of technical processes	CP1_U09
LO6	use various database technologies related to cloud computing	CP1_U10
	Social competences: the graduate is ready to	
LO7	self-education in order to learn about new trends in cloud technologies	CP1_K01
LO8	take actions in a planned manner and take responsibility for the results of cloud computing	CP1_K03
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	Lecture: one test;	W
LO2	Lecture: one test;	W
LO3	Lecture: one test;	W
LO4	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO5	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO6	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO7	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO8	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
Student workload (in hours)		No. of hours
Calculation	Lecture attendance	15
	Workshop attendance	30
	Preparation for lecture test(s)	9
	Preparation for specialistic workshop	12
	Preparation for workshop completion	4
	Participation in teacher-student sessions related to the module subject	5
	TOTAL	75
Quantitative indicators		Hours / ECTS
Student workload - activities that require direct teacher participation		50 / 2

Student workload - practical activities		51	2
Basic references	1. Dotson C., Bezpieczeństwo w chmurze. Przewodnik po projektowaniu i wdrażaniu zabezpieczeń. PWN, 2020. 2. Toroman M., Chmura Azure. Praktyczne wprowadzenie dla administratora. Helion, 2020. 3. Toroman M., Azure Networking Cookbook. Packt Publishing, 2020. 4. Marinescu D. C., Cloud Computing Theory and Practice. Elsevier 2013.		
Supplementary references	1. Costa F., Rethinking the Internet of Things, A Scalable Approach to Connecting Everything. Apress, 2014. 2. Dunko G., Misra J., Robertson J., Snyder T., A Reference Guide to the Internet of Things. Bridgera LLC, 2017. 3. Soldatos J., Building Blocks for IoT Analytics. River Publishers, 2017. 4. Lewis D., Database systems: Volume 1. University of London, 2016.		
Organisational unit conducting the course	Department of Automatic Control and Robotics	Date of issuing the programme	
Author of the programme	dr inż. Wojciech Wojtkowski	2022-06-07	

Bialystok University of Technology
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Field of study	**Industry Digitization**							Degree level and programme type	**full-time Bachelor's degree**
Specjalization / diploma path	**common subject**							Study profile	**general academic**
Course name	**Systems virtualization**							Course code	**CP1S06008**
								Course type	**elective**
Forms and number of hours of educational ectivities	L	C	LC	P	SW	FW	S	Semester	**6**
	15				**30**			No. of ECTS credits	**4**
Entry requirements	Process visualization, PLC programming, Industrial networks 1								
Course objectives	Acquisition of knowledge and skills in the field of design and programming of virtual models of machines, devices and industrial automation systems. Designing and programming models of production lines and conducting their simulations in real time. Support for cooperation of industrial manipulators.								
Course content	Lecture: Basic aspects of virtual reality elements in industrial automation systems. Designing, modeling and programming models of virtual elements of machines, devices and entire industrial automation systems. Support for PLCSIM and PLCSIM Advanced simulators. Programming models of machines, devices and systems in the SIMIT and Factory I/O environment. Conducting real-time simulations. Running hardware simulation. Building and servicing of virtual communication/distributed systems models. OPC UA interfaces for the SCADA system. Web-server support for remote access to process data and management. System integration with the data cloud. API programming. S7 communication. Designing control logic for the operation of models of electromechanical, hydraulic, pneumatic and drive systems. Virtual models of cooperation of industrial manipulators. Specialistic workshop: Solving problem tasks in the field of programming and testing control logic for the operation of models of electromechanical, hydraulic, pneumatic and drive systems, eg in TIA portal and SIMIT. Construction of production line models in Factory I/O. Programming cooperation of industrial manipulators. Testing the work of models. Conducting simulations of the operation of virtual models in PLCSIM and PLCSIM Advanced simulators. Programming of models of machines, devices and systems in the SIMIT environment. Conducting real-time simulations. Running hardware simulation. Programming and configuration of OPC UA communication interfaces in PLC and web-server devices. PLC integration, data logging and data processing to the data cloud.								
Teaching methods	Informative-problem lecture; Specialization workshop;								
Assessment method	Lecture: one test Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop								

Symbol of learning outcome	Learning outcomes	Reference to the learning outcomes for the field of study
	Knowledge: the graduate knows and understands	
LO1	basics of designing and programming models of virtual machines, devices and industrial automation systems	CP1_W01 CP1_W02 CP1_W03 CP1_W05 CP1_W07
LO2	basics of design and programming of production line models and cooperation of industrial manipulators	CP1_W02 CP1_W03 CP1_W05 CP1_W07
LO3	programming environments and simulators of industrial automation devices and systems for testing virtual models in real time	CP1_W02 CP1_W03 CP1_W05 CP1_W07
	Skills: the graduate is able to	
LO4	design and program models of virtual machines, devices and industrial automation systems	CP1_U07 CP1_U08 CP1_U09 CP1_U10
LO5	design and program production line models and cooperation of industrial manipulators	CP1_U07 CP1_U08 CP1_U09 CP1_U10
LO6	simulate the operation of virtual models of industrial automation systems in real time	CP1_U07 CP1_U08 CP1_U09 CP1_U10
	Social competences: the graduate is ready to	
LO7	critical assessment of knowledge in the field of designing and programming virtual models of machines, devices and industrial automation systems	CP1_K01

Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	Lecture: one test;	W
LO2	Lecture: one test;	W
LO3	Lecture: one test;	W
LO4	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO5	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO6	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO7	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps

Student workload (in hours)		No. of hours
Calculation	Lecture attendance	15
	Workshop attendance	30
	Preparation for lecture test(s)	19
	Preparation for specialistic workshop	24
	Preparation for workshop completion	7
	Participation in teacher-student sessions related to the module subject	5

	TOTAL	100	
Quantitative indicators		Hours	ECTS
Student workload - activities that require direct teacher participation		50	2
Student workload - practical activities		66	2,6
Basic references	1. https://support.industry.siemens.com/cs/products?mfn=ps&lc=en-PT 2. Krzyżanowski R., SIMATIC Motion Control - sterowanie serwonapędami, Helion, 2022. 3. https://www.biblioteka.siemens.academy/materials 4. www.profibus.com, www.profibus.org.pl (PNO), ://www.multiprojekt.pl/; Kanał youtube-#Pro_Tuto - komunikacja PLC i symulacja komunikacji 5. Tematy szkoleniowe: PLC SIM Advanced, Komunikacja OPC UA w sterownikach SIMATIC, programy do symulacji układów automatyki, platforma symulacyjna SIMIT.		
Supplementary references	1. Serwisy internetowe: https://automatykab2b.pl/, https://iautomatyka.pl/, https://strefainzyniera.pl/; https://www.multiprojekt.pl/ 2. Przemysł 4.0 w akcji – przykłady zastosowań - https://www.multiprojekt.pl/przemysl-4-0-w-akcji-przyklady-zastosowan-2/ 3. https://factoryio.com		
Organisational unit conducting the course	Department of Automatic Control and Robotics	Date of issuing the programme	
Author of the programme	dr hab. inż. Arkadiusz Mystkowski, prof. PB	2022-06-07	

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Field of study	**Industry Digitization**							Degree level and programme type	**full-time Bachelor's degree**
Specjalization / diploma path	**common subject**							Study profile	**general academic**
Course name	**Cyberphysical systems**							Course code	**CP1S06009**
								Course type	**elective**
Forms and number of hours of educational ectivities	L	C	LC	P	SW	FW	S	Semester	**6**
	15				**30**			No. of ECTS credits	**4**
Entry requirements	Process visualization, PLC programming, Industrial networks 1								
Course objectives	Acquisition of knowledge and skills in the field of active connection of devices, machines (including industrial robots) working autonomously equipped with integrated communication systems with their virtual models. Basics of connecting components of simulation models of machines and devices with mechanical and electronic parts of real machines and devices.								
Course content	Lecture: Structure of a cyber-physical system with a high degree of complexity. Designing and programming models of machines and devices and their integration in communication networks with their real counterparts working in industrial automation. Support for PLCSIM and PLCSIM Advanced simulators, SIMIT environment and NX MCD/Plant Simulation software. Running hardware simulation. Conducting simulations of the operation of cyber-physical systems in real time. Support for cooperation of industrial manipulators and elements of production lines with their virtual counterparts, the so-called digital machine twins. Design and programming of cyber physical systems. IT systems. Support for communication interfaces of machines and models. Building and servicing of virtual communication/distributed systems models. Design of control logic for the work of digital twins of machines and systems. Specialistic workshop: Implementation of problem projects in the field of design and programming of cyber-physical systems in the NC MCD/Plant Simulation environment. Conducting simulations of cyber-physical systems using API interfaces and the SIMIT environment. Building models of machines and devices in the Plant Simulation and SIMIT environment. Integration of models of virtual machines and devices with mechanical and electronic elements of real equivalents (machine twins). Programming of logic for controlling cyber physical systems in the TIA portal environment. Conducting simulations of the operation of cyber-physical systems in SIMIT, PLCSIM and PLCSIM Advanced simulators. Conducting real-time simulations. Running hardware simulation.								
Teaching methods	Informative-problem lecture; Specialization workshop;								
Assessment	Lecture: one test								

method	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop	
Symbol of learning outcome	Learning outcomes	Reference to the learning outcomes for the field of study
	Knowledge: the graduate knows and understands	
LO1	basics of construction and principles of operation of devices and machines (including industrial robots) as cyber-physical systems	CP1_W01 CP1_W02 CP1_W03 CP1_W05 CP1_W07
LO2	basic principles of connecting components of simulation models of machines and devices with mechanical and electronic parts of real machines and devices	CP1_W02 CP1_W03 CP1_W05 CP1_W07
LO3	tools for the design, modeling and simulation of cyber physical systems	CP1_W02 CP1_W03 CP1_W05 CP1_W07
	Skills: the graduate is able to	
LO4	design and model virtual models of devices and machines (including industrial robots) as cyber-physical systems	CP1_U07 CP1_U08 CP1_U09 CP1_U10
LO5	make active joining of components of simulation models of machines and devices with mechanical and electronic parts of real machines and devices	CP1_U07 CP1_U08 CP1_U09 CP1_U10
LO6	use tools for designing, modeling and simulating cyber-physical systems	CP1_U07 CP1_U08 CP1_U09 CP1_U10
	Social competences: the graduate is ready to	
LO7	critical assessment of knowledge in the field of designing and programming virtual models of machines, devices and industrial automation systems	CP1_K01
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	Lecture: one test;	W
LO2	Lecture: one test;	W
LO3	Lecture: one test;	W
LO4	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO5	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO6	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO7	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
Student workload (in hours)		No. of hours
	Lecture attendance	15
	Workshop attendance	30
	Preparation for lecture test(s)	19

Calculation	Preparation for specialistic workshop	24	
	Preparation for workshop completion	7	
	Participation in teacher-student sessions related to the module subject	5	
	TOTAL	100	
Quantitative indicators		Hours	ECTS
Student workload - activities that require direct teacher participation		50	2
Student workload - practical activities		66	2,6
Basic references	1. https://support.industry.siemens.com/cs/products?mfn=ps&lc=en-PT 2. Krzyżanowski R., SIMATIC Motion Control - sterowanie serwonapędami, Helion, 2022. 3. https://www.biblioteka.siemens.academy/materials 4. www.profibus.com, www.profibus.org.pl (PNO), ://www.multiprojekt.pl/; Kanał youtube-#Pro_Tuto - komunikacja PLC i symulacja komunikacji 5. Tematy szkoleniowe: PLC SIM Advanced, Komunikacja OPC UA w sterownikach SIMATIC, programy do symulacji układów automatyki, platforma symulacyjna SIMIT.		
Supplementary references	1. Serwisy internetowe: https://automatykab2b.pl/, https://iautomatyka.pl/, https://strefainzyniera.pl/ 2. Przemysł 4.0 w akcji – przykłady zastosowań - https://www.multiprojekt.pl/przemysl-4-0-w-akcji-przyklady-zastosowan-2/ 3. https://factoryio.com		
Organisational unit conducting the course	Department of Automatic Control and Robotics	Date of issuing the programme	
Author of the programme	dr hab. inż. Arkadiusz Mystkowski, prof. PB	2022-06-07	

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Field of study	**Industry Digitization**							Degree level and programme type	**full-time Bachelor's degree**
Specjalization / diploma path	**common subject**							Study profile	**general academic**
Course name	**Industrial networks 2**							Course code	**CP1S06010**
								Course type	**obligatory**
Forms and number of hours of educational ectivities	L	C	LC	P	SW	FW	S	Semester	**6**
	15				**45**			No. of ECTS credits	**6**
Entry requirements	Industrial networks 1								
Course objectives	Acquainting with Ethernet communication systems in industrial automation network systems using high level protocols such as TCP/IP, IRT, RT and PROFIsafe. Teaching how to use EtherNet/IP, PROFINET IO, EtherCAD, ISO on TCP, MQTT, OPC UA and Modbus TCP. Teaching the principles of designing, commissioning, servicing and diagnostics of industrial PLC networks and peripheral devices in DCS systems.								
Course content	Lecture: Structure of the Ethernet protocol. The OSI model. Cyclic and acyclic communication. Diagnostics of networks and peripherals. Support for EtherNet/IP, EtherCAD and Modbus TCP protocols. Programming of functions for MQTT and ISO on TCP communication. Architecture profile of TCP/IP, RT, IRT protocols. Physical and application layer of the PROFINET IO network. Support for RT, IRT, and non-RT operating modes. Design of PROFIsafe network safety systems. Principles for the configuration and operation of devices in the PROFIsafe network. Safety categories for equipment controlled by an industrial network. Designing network redundant systems. Communication functions in a PROFINET IO network using PLCs. Specialistic workshop: Realization of problem projects consisting of communication tasks of DCS systems in Ethernet, PROFINET IO, EtherCAD. Application of the MQTT protocol. Design and simulation of the system with OPC UA communication, API and the use of a web-server. Synchronous communication of master and slave units with support for selected system interrupts. Hardware and program support for PLC and peripheral devices. Programming of cyclic, acyclic process data communication in the TCP/IP/RT/IRT mode. Building a network topology. Performing diagnostics of the physical and application layer. Asynchronous communication of peripheral devices. Project of a PROFINET IO network for an exemplary Safety system. Design of a redundant network based on the PROFINET IO standard. Design of a decentralized safety system using PROFIsafe.								
Teaching methods	Informative-problem lecture; Specialization workshop;								
Assessment	Lecture: exam								

method	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop	
Symbol of learning outcome	Learning outcomes	Reference to the learning outcomes for the field of study
	Knowledge: the graduate knows and understands	
LO1	operating principle of Ethernet, TCP/IP, IRT, RT and PROFIsafe protocols	CP1_W10
LO2	functions for decentralized data exchange in an industrial communication system	CP1_W10
LO3	methods of diagnostics of industrial networks and peripheral devices	CP1_W10
	Skills: the graduate is able to	
LO4	configure, commission and test communication connections in the PROFIsafe network, PROFINET IO and the redundant system	CP1_U07
LO5	program functions for real-time data exchange in an industrial network	CP1_U07
LO6	use selected methods for diagnostics of industrial networks for the physical and application layer	CP1_U07
	Social competences: the graduate is ready to	
LO7	critical assessment of knowledge and skills in the design and operation of network automation systems, as well as compliance with the rules of professional ethics	CP1_K01
Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	Lecture: exam;	W
LO2	Lecture: exam;	W
LO3	Lecture: exam;	W
LO4	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO5	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO6	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
LO7	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	Ps
Student workload (in hours)		No. of hours
Calculation	Lecture attendance	15
	Workshop attendance	45
	Preparation for the lecture exam; participation in the exam	33
	Preparation for specialistic workshop	40
	Preparation for workshop completion	12

	Participation in teacher-student sessions related to the module subject	5	
	TOTAL	150	
Quantitative indicators		Hours	ECTS
Student workload - activities that require direct teacher participation		67	2,7
Student workload - practical activities		102	4,1
Basic references	1. Mystkowski A., Sieci przemysłowe PROFIBUS DP i PROFINET IO, Oficyna Wydawnicza Politechniki Białostockiej, 2012. 2. Michta E., Modele komunikacyjne sieciowego systemu pomiarowo-sterującego, Wydawnictwo Politechniki Zielonogórskiej, Zielona Góra, 2000. 3. Pigan R., Metter M., Automating with PROFINET: Industrial communication based on industrial Ethernet. 2nd Edition, 2015. 4. Ethernet, 2nd ed., Siemens, 2006. 5. Popp M., Weber K., The rapid way to PROFINET, PNO, 2004.		
Supplementary references	1. Comer D. E., Sieci komputerowe i intersieci: aplikacje internetowe, Ed. 4, WNT, Warszawa 2000. 2. PROFINET specyfikacje: IEC 61784-1; IEC 61784-2; IEC 61784-5; IEC 61158-4, IEC 61158-5 oraz IEC61784. 3. https://www.profibus.com, www.profibus.org.pl (PNO), www.biblioteka.siemens.academy/materials; https://support.industry.siemens.com/cs/products?mfn=ps&lc=en-PT, https://www.multiprojekt.pl/; Kanał youtube-#Pro_Tuto - komunikacja PLC i symulacja komunikacji		
Organisational unit conducting the course	Department of Automatic Control and Robotics	Date of issuing the programme	
Author of the programme	dr hab. inż. Arkadiusz Mystkowski, prof. PB	2022-06-07	