Bialystok University of Technology									
Field of study	**Automatic Control and Robotics**							Degree level and programme type	**full-time Master's degree**
Specjalization / diploma path	**industrial process control**							Study profile	**general academic**
Course name	**Interim work project**							Course code	**MYAR2S12001**
								Course type	**elective**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**2**
	0	**0**	**0**	**30**	**0**	**0**	**0**	No. of ECTS credits	**2**
Entry requirements	-								
Course objectives	Acquisition of substantive and practical principles of design, operation and use of industrial automatic control systems.								
Course content	Synthesis of linear and nonlinear automatic control systems with the use of computer techniques. Identification of the object, controller and accessories. Study of the stability, static and dynamic performance of models of automatic control systems. Programming of real-time control systems. Rules for the use and operation of process control systems. Ability to use design aiding programs (EPLAN, LabView). Themes of projects: design of control systems used in industry, communication, machines, engines and installations.								
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
LO1	knows and can use advanced methods of designing elements and analog and digital automatic control and robotics systems	AR2_W04 AR2_U01 AR2_U03
LO2	knows and understands concepts and principles in the field of intellectual, industrial, copyright and patent protection	AR2_W09
LO3	is able to model and design control objects and industrial and service processes	AR2_W02 AR2_U01 AR2_U02
LO4	is ready to analyze and critical assessment of prepared technical solutions and recognition of the importance of knowledge in various fields of science	AR2_K01 AR2_K02

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

Student workload (in hours)		No. of hours
Calculation	Project attendance	30
	Preparation for project classes	2
	Working on projects (including preparation of presentations)	12
	Preparation for projects completion	1
	Participation in teacher-student sessions related to the module subject	5
	TOTAL	50

Quantitative indicators	Hours	ECTS
Student workload - activities that require direct teacher participation	35	1,4
Student workload - practical activities	50	2

Basic references	
	1. Kaczorek T., Dzieliński A., Dąbrowski W., Łopatka R., Podstawy teorii sterowania. WNT, Warszawa 2005. 2. Kost G., Łebkowski P., Węsierski Ł. N., Automatyzacja i robotyzacja procesów produkcyjnych. Polskie Wydawnictwo Ekonomiczne, Warszawa 2013. 3. Siemieniako F., Peszyński K., Automatyka w przykładach i zadaniach. Wydawnictwo Politechniki

	Białostockiej. Białystok, 2005. 4. Siemieniako F., Gosiewski Z., Automatyka. Modelowanie i analiza układów. T. 1. Wydawnictwo Politechniki Białostockiej. Białystok, 2006. 5. Gosiewski Z., Siemieniako F., Automatyka. Synteza układów. T. 2. Wydawnictwo Politechniki Białostockiej. Białystok, 2006.	
Supplementary references	1. Ogata K., Modern control engineering, 4th ed., Pearson Education International, 2002. 2. Mikulczyński T., Automatyzacja procesów produkcyjnych: metody modelowania procesów dyskretnych i programowania sterowników PLC, PWN, Wydawnictwo 2, Warszawa, 2017. 3. Honczarenko J., Elastyczna automatyzacja wytwarzania. WNT Warszawa 2000. 4. Flasiński M., Wstęp do sztucznej inteligencji. Wydawnictwo Naukowe PWN, Warszawa 2018. 5. Giergiel M. J., Hendzel Z., Żylski W., Modelowanie i sterowanie mobilnych robotów kołowych. Wydawnictwo Naukowe PWN, Warszawa 2013.	
Organisational unit conducting the course	Katedra Automatyki i Robotyki	Date of issuing the programme
Author of the programme	prof. dr hab. inż. Zdzisław Gosiewski	2019-09-23

Bialystok University of Technology									
Field of study	**Automatic Control and Robotics**							Degree level and programme type	**full-time Master's degree**
Specjalization / diploma path	**industrial process control**							Study profile	**general academic**
Course name	**Networked automation systems**							Course code	**MYAR2S12002**
								Course type	**elective**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**2**
	30	**0**	**15**	**15**	**0**	**0**	**0**	No. of ECTS credits	**5**
Entry requirements	-								
Course objectives	Acquainting with communication systems in network automation systems that use high-level protocols such as TCP / IP, IRT, RT and PROFIsafe. Communication of PLC modules, distributed measurement systems, actuators and decentralized controllers. Teaching design principles, drawing electrical and signal diagrams for network peripherals. Gaining knowledge and skills in industrial network systems and diagnostics.								
Course content	Lecture: Structure of the Ethernet protocol. Profile architecture of TCP / IP, RT and IRT protocols. The physical and application layer of the PROFINET IO network. Support for RT, IRT, non-RT operating modes. Designing PROFIsafe network security systems. The rules for setting up and operating devices in the PROFIsafe network. Security categories of devices controlled by the industrial network. Designing network redundant systems. Communication functions in the PROFINET IO network in the SIMATIC system using PLCs. Cyclic and acyclic communication. Diagnostics of networks and peripherals. Principles of drawing electrical and signal diagrams for network peripherals. Laboratory: Programming of OB blocks, FC / FB functions and support of DB data blocks required to perform communication tasks in the Ethernet / PROFINET IO network. Familiarization with the principles of operating PLC peripheral devices, the structure of the industrial network and health and safety guidelines. Configuration of PC connections. Set the data exchange cycle and information refresh cycle and parameterization of network devices. TCP / IP / RT / IRT mode configuration. Building various network topologies. Programming of cyclical exchange of process data. Performing physical and application layer diagnostics. Project: Decentralized drive control. Asynchronous communication of peripheral devices. PROFINET IO network design for an exemplary Safety system. Redundant network project based on the PROFINET IO standard. Design of a decentralized security system using PROFIsafe. Synchronous communication of master and slave units with support for selected system interrupts.								
Teaching methods	Informative-problem lecture; Laboratory classes; Project classes;								
Assessment method	Lecture: exam Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes 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
LO1	knows the principle of operation of Ethernet, TCP / IP, IRT, RT and PROFIsafe protocols	AR2_W05
LO2	knows functions for decentralized data exchange in the industrial communication system	AR2_W03 AR2_W05 AR2_U03 AR2_U06
LO3	knows diagnostics methods for industrial networks and peripherals	AR2_W02 AR2_W05
LO4	can configure, run and test communication connections in PROFIsafe, PROFINET IO and system redundant	AR2_U03
LO5	is able to program functions for real-time data exchange in an industrial network	AR2_U03
LO6	can use selected methods for diagnostics of industrial networks for physical and application layer	AR2_U03 AR2_U05
LO7	is ready to critically evaluate his/her knowledge and skills in the design and maintenance of network automation systems, and to comply with the principles of professional ethics	AR2_K01 AR2_K07

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; Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	W L P
LO3	Lecture: exam;	W
LO4	Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	L P
LO5	Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	L P
LO6	Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	L P
LO7	Lecture: exam; Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	W L P

Student workload (in hours)		No. of hours
Calculation	Lecture attendance	30
	Laboratory classes attendance	15
	Project attendance	15
	Preparation for the lecture exam; participation in the exam	16
	Preparation for laboratory classes	12
	Preparation for laboratory classes completion	3
	Preparation for project classes	18
	Working on projects (including preparation of presentations)	6
	Preparation for projects completion	5
	Participation in teacher-student sessions related to the module subject	5
	TOTAL	125

Quantitative indicators	Hours	ECTS
Student workload - activities that require direct teacher participation	67	2,7
Student workload - practical activities	79	3,2

Basic references	1. Mystkowski A., Sieci przemysłowe PROFIBUS DP i PROFINET IO, Oficyna Wydawnicza Politechniki Białostockiej, 2012. 2. Pigan R., Metter M., Automating with PROFINET: Industrial communication based on industrial Ethernet. 2nd Edition, 2015. 3. Ethernet, 2nd ed., Siemens, 2006. 4. Popp M., Weber K., The rapid way to PROFINET, PNO, 2004. 5. Michta E., Modele komunikacyjne sieciowego systemu pomiarowo-sterującego, Wydawnictwo Politechniki Zielonogórskiej, Zielona Góra, 2000.
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. PN EN 61131-3:2004 Sterowniki programowalne: języki programowania. 4. www.profibus.com, www.profibus.org.pl (PNO).

Organisational unit conducting the course	Katedra Automatyki i Robotyki	Date of issuing the programme
Author of the programme	dr hab. inż. Arkadiusz Mystkowski	2019-09-23

Bialystok University of Technology									
Field of study	**Automatic Control and Robotics**							Degree level and programme type	**full-time Master's degree**
Specjalization / diploma path	**industrial process control**							Study profile	**general academic**
Course name	**Testing of control systems**							Course code	**MYAR2S12003**
								Course type	**elective**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**2**
	15	**0**	**30**	**0**	**0**	**0**	**0**	No. of ECTS credits	**4**
Entry requirements	Control theory, Real time controllers								
Course objectives	Acquaintance with the structure and principle of operation of analog-digital and digital-analog channels in control systems. Gaining knowledge about functions, structure and methods of programming (configuring) microprocessor controllers. Acquiring knowledge and skills in calibrating measurement paths and programming signals to control actuators. Transfer of knowledge in the field of testing continuous and discrete control systems. Gaining knowledge in the field of application of control and measurement systems in experimental research.								
Course content	Lecture: Closed-loop systems: types and structure. Control and measurement modules and software in control systems. Measurement signal processing. The role of A/D and D/A converters in the automatic control system. HART protocol, wireless measuring systems, modem and optical systems. Microprocessor controllers - implemented functions, program layers, configuration. Control of basic physical quantities, including liquid level, pressure, rotational speed, flow rate. Testing the single-circuit control systems - computer modeling and simulation of work, examples of implementation in practice. Laboratory: ADAM control and measurement modules - communication, limitations, parameters. Calibration of measuring channels. Testing continuous control systems. Selection of controller settings in test applications. Examination of the adjustment process of pneumatics and electrohydraulic systems. Simulation of work and testing of selected control systems in computer software.								
Teaching methods	Informative-problem lecture; Laboratory classes;								
Assessment method	Lecture: one test Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes								
Symbol of learning outcome	Learning outcomes							Reference to the learning outcomes for the field of study	
LO1	knows and understands the structure of control systems, the role of A/D and D/A converters in automation systems, selects tools and techniques in modular control and measurement systems, measurement protocols							AR2_W04 AR2_U03 AR2_K01	
LO2	knows the structure, functions and configuring of microprocessor controllers							AR2_W04 AR2_U03	
LO3	uses control and measurement modules to build and test control systems							AR2_U04	
LO4	selects the type and settings of the controller and uses and programs microprocessor controllers to test control systems							AR2_U03 AR2_U04	
LO5	experiments with continuous process control systems, tests the correct operation of systems							AR2_W06 AR2_U05	
LO6	calibrates measuring channels in automation systems							AR2_W06 AR2_U05	
Symbol of learning outcome	Methods of assessing the learning outcomes							Type of tuition during which the outcome is assessed	
LO1	Lecture: one test; Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes;							W L	
LO2	Lecture: one test; Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes;							W L	
LO3	Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes;							L	
LO4	Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes;							L	
LO5	Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes;							L	

LO6	Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes;	L
Student workload (in hours)		No. of hours
Calculation	Lecture attendance	15
	Laboratory classes attendance	30
	Preparation for lecture test(s)	24
	Preparation for laboratory classes	20
	Preparation for laboratory classes completion	6
	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		61 / 2,4
Basic references	1. Kulesza Z., Ćwiczenia laboratoryjne z urządzeń automatyki. Regulatory konfigurowalne. Wydawnictwo Politechniki Białostockiej, Białystok 2006. 2. Turkowski M., Przemysłowe sensory i przetworniki pomiarowe. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2002. 3. Suchocki K., Sensory i przetworniki pomiarowe: laboratorium. Wydaw. Politechniki Gdańskiej, Gdańsk, 2016. 4. Nawrocki W., Komputerowe systemy pomiarowe. WKiŁ, Warszawa, 2006. 5. Nawrocki W., Rozproszone systemy pomiarowe. WKiŁ, Warszawa 2006.	
Supplementary references	1. Kwaśniewski J., Programowalne sterowniki przemysłowe w systemach sterowania. Wydawnictwa AGH, Kraków, 1999. 2. Piotrowski J. (red.), Pomiary: czujniki i metody pomiarowe wybranych wielkości fizycznych i składu chemicznego. WNT, Warszawa, 2009. 3. Jędrzejkiewicz Z., Teoria sterowania układów jednowymiarowych. Uczelniane Wydawnictwa Naukowo-Dydaktyczne AGH, Kraków, 2004. 4. Ogata K., Designing Linear Control Systems with MatLab. Prentice Hall, Englewood Cliffs, New Jersey, 1996. 5. Pawlak A.M., Sensors and actuators in mechatronics: design and applications. Boca Raton: CRC/Taylor & Francis, 2007.	
Organisational unit conducting the course	Katedra Automatyki i Robotyki	Date of issuing the programme
Author of the programme	dr inż. Adam Kotowski	2019-09-23

Bialystok University of Technology									
Field of study	**Automatic Control and Robotics**							Degree level and programme type	**full-time Master's degree**
Specjalization / diploma path	**industrial process control**							Study profile	**general academic**
Course name	**Decision support in technical diagnostics**							Course code	**MYAR2S12004**
								Course type	**elective**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**2**
	15	**0**	**0**	**15**	**0**	**0**	**0**	No. of ECTS credits	**2**
Entry requirements	Signal and image processing								
Course objectives	Transfer of knowledge necessary to carry out correct practical activities in the operation of machines. Demonstration of relationships between the optimal decision (information) and system performance. Presentation of the importance of decisions in the optimization of activities in the organization of systems.								
Course content	Lecture: Cybernetic system of facility operation. System destruction (dysregulation, wear and failure). Newtonian and Bergsonian time. Control susceptibility of the system - object and controller correction. Control potential - relationships between multi-criteria (optimal) control and technical/reliability state of the system. Phase portrait in the process of evaluating the state of system regulation. Relations of the Lapunov function with the energy state of the system. Diagnostic susceptibility of the machine. Relationships between the state of operation, technical condition and reliability of the object. Damage as a significant change in signal, parameter, system potential. Types of damage - catastrophic, parametric, transient. Determination of individual reliability characteristics based on parametric and transient failures. The importance of "risk" in the decision-making process. Project: Genesis, prognosis and assessment of technical condition of machines.								
Teaching methods	Informative-problem lecture; Project classes;								
Assessment method	Lecture: one test 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
LO1	knows and understands the processes occurring in the life cycle of devices, objects and technical systems in the field of automation and robotics	AR2_W02
LO2	knows decision support systems, modeling decision situations, uncertainty representation and multi-criteria analysis	AR2_W01 AR2_W02
LO3	is able to lead a discussion on the implementation of the project task	AR2_U05 AR2_U08
LO4	is ready to fulfill social obligations resulting from the needs of technical diagnostics	AR2_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	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

Student workload (in hours)		No. of hours
Calculation	Lecture attendance	15
	Project attendance	15
	Preparation for lecture test(s)	3
	Preparation for project classes	4
	Working on projects (including preparation of presentations)	6
	Preparation for projects completion	2
	Participation in teacher-student sessions related to the module subject	5
	TOTAL	50

Quantitative indicators		Hours	ECTS
Student workload - activities that require direct teacher participation		35	1,4
Student workload - practical activities		32	1,3
Basic references	1. Cempel C., Teoria i inżynieria systemów. Wydawnictwo WITE, Radom 2006. 2. Lindstedt P., Sudakowski T., Grądzki R., Eksploatacyjna niezawodność maszyny i jej teoretyczne podstawy. Wydawnictwo ITWL, Warszawa 2016. 3. Lindstedt P., Praktyczne regulacja maszyn i jej teoretyczne podstawy. Wydawnictwo ITWL, Warszawa 2012. 4. Lindstedt P., Praktyczna diagnostyka maszyn i jej teoretyczne podstawy. Wydawnictwo Naukowe ASKON, Warszawa 2002.		
Supplementary references	1. Bubnicki Z., Podstawy informatycznych systemów zarządzania. Wydawnictwo WPWr, Wrocław 1993.		
Organisational unit conducting the course	Katedra Automatyki i Robotyki	Date of issuing the programme	
Author of the programme	dr inż. Rafał Grądzki	2019-09-23	

<table>
<tr><td colspan="10">Bialystok University of Technology</td></tr>
<tr><td>Field of study</td><td colspan="6">Automatic Control and Robotics</td><td>Degree level and programme type</td><td>full-time Master's degree</td></tr>
<tr><td>Specjalization / diploma path</td><td colspan="6">industrial process control</td><td>Study profile</td><td>general academic</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="6" rowspan="2">Automation and robotization systems</td><td>Course code</td><td>MYAR2S12005</td></tr>
<tr><td>Course type</td><td>elective</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td>2</td></tr>
<tr><td>45</td><td>0</td><td>0</td><td>30</td><td>0</td><td>0</td><td>0</td><td>No. of ECTS credits</td><td>6</td></tr>
<tr><td>Entry requirements</td><td colspan="9">-</td></tr>
<tr><td>Course objectives</td><td colspan="9">Acquainting with the concepts of robotization, automation. Analysis of selected robotization systems, automation of service, production and industrial processes as well as building automation systems. Teaching procedures for designing robotization and automation systems and creating documentation using computer-aided engineering design environments. Introduction to the use of robots and the structure and operation of robotic systems. The use of CAD and multimedia techniques to design and visualize the technical solution.</td></tr>
<tr><td>Course content</td><td colspan="9">Lecture: Basic concepts: production, production processes, automated processes, automatic processes, automation, automation system, automation and automatic control. Advantages and disadvantages of introducing automation of service, production, industrial processes and building automation. Technological unemployment. The process of production / industrial processes automation and building automation. Internet of Things. The use of internet technologies in the automation of homes, cities, enterprises, energy systems, measurement systems, environmental monitoring processes and risk monitoring. Comprehensive automation. Automation tool - programmable logic controllers (PLC). Pneumatic and hydraulic automation systems. Production and service processes. Robotic system, its components and configurations. Transport in the immediate vicinity of the robot. Control of a robotic system. Examples of the use of robots: close transport, assembly, painting, welding, dosing, testing and inspection, agriculture and forestry, processing industry, services, medicine and rehabilitation. Development trends and the latest achievements in the field of automation and robotics. Industry 4.0. Project: Design of robotic systems, automation of service, production / industrial processes and automation systems of buildings. Principles of preparing documentation of the designed automation system. Consideration of the robot's use; robot selection; products, scenarios and visions of industrial and service robotization. Designing grippers and other end effectors: drives; structural forms; interfacing. Non-technical aspects of robotization: economic-organizational, social, ethical. Robot application planning techniques.</td></tr>
<tr><td>Teaching methods</td><td colspan="9">Informative-problem lecture; Project classes;</td></tr>
<tr><td>Assessment method</td><td colspan="9">Lecture: two tests
Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Learning outcomes</td><td colspan="2">Reference to the learning outcomes for the field of study</td></tr>
<tr><td>LO1</td><td colspan="7">knows the concepts related to automation and robotization</td><td colspan="2">AR2_W03</td></tr>
<tr><td>LO2</td><td colspan="7">gives the steps and describes the essence of designing robotization systems, automation of service, production and industrial processes, and automation of buildings</td><td colspan="2">AR2_W04</td></tr>
<tr><td>LO3</td><td colspan="7">lists and analyzes examples of robotization systems, automation of service, production and industrial processes and automation of buildings, analyzes existing technical solutions including the most important new achievements in this field</td><td colspan="2">AR2_W07</td></tr>
<tr><td>LO4</td><td colspan="7">designs selected systems of robotization and automation using computer-aided environments for engineering design</td><td colspan="2">AR2_U01 AR2_U02 AR2_U03</td></tr>
<tr><td>LO5</td><td colspan="7">identifies non-technical aspects of robotization and automation systems</td><td colspan="2">AR2_U07</td></tr>
<tr><td>Symbol of learning outcome</td><td colspan="7">Methods of assessing the learning outcomes</td><td colspan="2">Type of tuition during which the outcome is assessed</td></tr>
<tr><td>LO1</td><td colspan="7">Lecture: two tests;</td><td colspan="2">W</td></tr>
</table>

LO2	Lecture: two tests;	W	
LO3	Lecture: two tests;	W	
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	
Student workload (in hours)		No. of hours	
Calculation	Lecture attendance	45	
	Project attendance	30	
	Preparation for lecture test(s)	22	
	Preparation for project classes	28	
	Working on projects (including preparation of presentations)	12	
	Preparation for projects completion	8	
	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		80	3,2
Student workload - practical activities		83	3,3
Basic references	1. Marciniak M., Elementy automatyzacji we współczesnych procesach wytwarzania. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2007. 2. Mikulczyński T., Samsonowicz Z., Więcławek R., Automatyzacja procesów produkcyjnych. Wydawnictwo Naukowe PWN, Warszawa, 2017. 3. Świder J. (red.), Sterowanie i automatyzacja procesów technologicznych układów mechatronicznych. Układy pneumatyczne i elektropneumatyczne ze sterowaniem logicznym (PLC). Wydawnictwo Politechniki Śląskiej, Gliwice 2015. 4. Kost G., Łebkowski P., Węsierski Ł., Automatyzacja i robotyzacja procesów produkcyjnych. PWE Polskie Wydawnictwo Ekonomiczne. Warszawa, 2013. 5. Gawrysiak M., Wykłady: Robotyzacja 2004, (dostępne w postaci plików pdf).		
Supplementary references	1. Zdanowicz R., Robotyzacja dyskretnych procesów produkcyjnych, Wydawnictwo Politechniki Śląskiej, 2013. 2. Matyszewska E. (red.), Automatyzacja przemysłu spożywczego Casebook. Wydawnictwo Naukowe PWN. Warszawa, 2016. 3. Kaczmarek W., Panasiuk J., Robotyzacja procesów produkcyjnych, PWN, 2017. 4. Serwisy internetowe: iAutomatyka.pl, eplan.pl, astor.com.pl, automatykab2b.pl, aps.pl., inne czasopisma, branżowe, bazy danych intechopen.com, bazy patentów Google Patents, bazy publikacji Google Scholar, zdalne bazy czasopism naukowych PB		
Organisational unit conducting the course	Katedra Automatyki i Robotyki	Date of issuing the programme	
Author of the programme	dr inż. Roman Trochimczuk	2019-09-23	

Bialystok University of Technology									
Field of study	**Automatic Control and Robotics**							Degree level and programme type	**full-time Master's degree**
Specjalization / diploma path	**industrial process control**							Study profile	**general academic**
Course name	**Nonlinear control systems**							Course code	**MYAR2S12006**
								Course type	**elective**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**2**
	30	**0**	**0**	**30**	**0**	**0**	**0**	No. of ECTS credits	**6**
Entry requirements	-								
Course objectives	Acquainting with methods of testing stability of nonlinear control systems. Acquainting with the ideas of designing non-linear control systems, adaptive model following systems, selected adaptive control algorithms.								
Course content	Lecture: Description of dynamic linear and nonlinear systems in the state space. Stability of nonlinear control systems. Direct and indirect Lapunov method. Modifications of the direct Lapunov method. Lapunov's steering function. La Salle's theorem. Uncertainty in the object model - resistant and adaptive systems. Adaptive system following the linear reference model. Selected adaptive algorithms. Project: Stability testing of selected nonlinear control systems. Practical implementation of selected adaptive and follow-up control algorithms. Analysis of the influence of control parameters on the system behavior.								
Teaching methods	Informative-problem lecture; Project classes;								
Assessment method	Lecture: exam 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
LO1	knows and is able to use basic concepts to describe and analyze of a non-linear control system	AR2_W01 AR2_U01
LO2	understands the concepts of stability of a non-linear control system and knows the methods for testing stability (including the Lapunov method)	AR2_W01 AR2_W03
LO3	knows the sources of uncertainty in the object model and is able to analyze them	AR2_W03 AR2_W04 AR2_U02 AR2_U05
LO4	is ready to analyze and interpret necessary information from various sources and comply with professional ethics	AR2_K01 AR2_K07

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

Student workload (in hours)		No. of hours
Calculation	Lecture attendance	30
	Project attendance	30
	Preparation for the lecture exam; participation in the exam	29
	Preparation for project classes	34
	Working on projects (including preparation of presentations)	12
	Preparation for projects completion	10
	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	91	3,6

Basic references	1. Kabziński J., Projektowanie nieliniowych układów sterowania. PWN, Warszawa 2018. 2. Gessing R., Skrzywan-Kosek A., Latarnik M., Zbiór zadań z teorii sterowania układami nieliniowymi, Wydawnictwo Politechniki Śląskiej 2006.	
Supplementary references	1. Isidori A., Nonlinear control systems, Springer 1991. 2. Górecki H., Optymalizacja i sterowanie systemów dynamicznych, AGH 2006.	
Organisational unit conducting the course	Katedra Automatyki i Robotyki	Date of issuing the programme
Author of the programme	dr hab. Ewa Pawłuszewicz, prof. PB	2019-09-23

Bialystok University of Technology									
Field of study	**Automatic Control and Robotics**							Degree level and programme type	**full-time Master's degree**
Specjalization / diploma path	**industrial process control**							Study profile	**general academic**
Course name	**Control of manufacturing processes**							Course code	**MYAR2S12007**
								Course type	**elective**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**2**
	15	**0**	**15**	**30**	**0**	**0**	**0**	No. of ECTS credits	**5**
Entry requirements	-								
Course objectives	Acquainting with the possibilities of controlling production processes based on the Internet, Ethernet, ASI Bus, Profinet, Profibus using PLC controllers. Familiarization with the programming of industrial robots. Acquainting with the manipulator motion programming based on the vision system.								
Course content	Acquainting with the possibilities of controlling production processes based on the Internet, Ethernet, ASI Bus, Profinet, Profibus using PLC controllers. Familiarize with the programming of industrial robots. Acquainting with the manipulator motion programming based on the vision system.								
Teaching methods	Informative-problem lecture; Laboratory classes; Project classes;								
Assessment method	Lecture: one test Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes 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
LO1	knows the methods of PLC configuration necessary for the implementation of industrial wired communication using the available communication interfaces	AR2_W02 AR2_W04
LO2	knows and understands the principles of modern industrial networks	AR2_W02 AR2_W04 AR2_W07
LO3	can configure and program Siemens PLCs in the TIA Portal environment based on available electrical schemes	AR2_U01 AR2_U03 AR2_U09
LO4	can test his/her own algorithms and control programs implemented on the PLC controller on individual work stations of the production line	AR2_U03 AR2_U04
LO5	can manage the work of the team to solve a complex technical problem	AR2_U10

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	Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	L P
LO4	Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	L P
LO5	Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	L P

	Student workload (in hours)	No. of hours
Calculation	Lecture attendance	15
	Laboratory classes attendance	15
	Project attendance	30
	Preparation for lecture test(s)	13
	Preparation for laboratory classes	11
	Preparation for laboratory classes completion	3
	Preparation for project classes	16
	Working on projects (including preparation of presentations)	12

	Preparation for projects completion	5	
	Participation in teacher-student sessions related to the module subject	5	
	TOTAL	125	
Quantitative indicators		Hours	ECTS
Student workload - activities that require direct teacher participation		65	2,6
Student workload - practical activities		97	3,9
Basic references	1. Mystkowski A., Sieci przemysłowe PROFIBUS DP i PROFINET IO, Oficyna Wydawnicza Politechniki Białostockiej, Białystok 2012. 2. Solnik W., Zajda Z., Sieci przemysłowe, Profibus-DP, Profinet, AS-I, EGD, Przykłady zastosowań. Wydawnictwo BTC, 2018. 3. Kwiecień R., Komputerowe systemy w automatyce przemysłowej, Wydawnictwo Helion, 2013. 4. Kaczmarek W., Programowanie robotów przemysłowych. Wydawnictwo PWN, 2017.		
Supplementary references	1. Podręczniki szkoleniowe firmy FESTO do poszczególnych stacji roboczych dostępnych na stanowisku elastycznej linii produkcyjnej. 2. Materiały szkoleniowe firmy SIEMENS z programowania sterowników PLC w środowisku TIA Portal, 2013.		
Organisational unit conducting the course	Katedra Automatyki i Robotyki	Date of issuing the programme	
Author of the programme	dr inż. Andrzej Koszewnik	2019-09-23	

Bialystok University of Technology									
Field of study	**Automatic Control and Robotics**							Degree level and programme type	**full-time Master's degree**
Specjalization / diploma path	**computer systems**							Study profile	**general academic**
Course name	**Interim work project**							Course code	**MYAR2S22001**
								Course type	**elective**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**2**
	0	**0**	**0**	**30**	**0**	**0**	**0**	No. of ECTS credits	**2**
Entry requirements	-								
Course objectives	Acquiring the substantive and practical principles of design, operation and use of computerized robotic systems.								
Course content	Synthesis of linear and non-linear control systems using computer techniques. Identification of the object, controller and elements of robotic information systems. Study of the stability, static and dynamic quality of models of automatic control systems. Programming of real-time control systems. Rules for the use and operation of information systems, especially in the field of mobile robotics. The ability to use computer programs that support design (Adams, RobWork). Topics of projects: design of subassemblies and complete mobile robots, autonomy and cooperation of robots, base stations and their telemetry links.								
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
LO1	knows the principles of designing automatic control and robotics systems and is able to use them	AR2_W04, AR2_U01, AR2_U03
LO2	knows theories, methods and engineering tools to manage robotic systems and can use them	AR2_W05, AR2_U03, AR2_U04
LO3	can use wired and wireless telecommunications systems	AR2_U03
LO4	can design subassemblies and complete mobile robots	AR2_U01, AR2_U03
LO5	can evaluate designed robotic systems and discuss simulation results or experiment	AR2_U05

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

Calculation	Student workload (in hours)	No. of hours
	Project attendance	30
	Preparation for project classes	2
	Working on projects (including preparation of presentations)	12
	Preparation for projects completion	1
	Participation in teacher-student sessions related to the module subject	5
	TOTAL	50

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

Student workload - practical activities		50	2
Basic references	1. Kost G., Łebkowski P., Węsierski Ł. N., Automatyzacja i robotyzacja procesów produkcyjnych. Polskie Wydawnictwo Ekonomiczne, Warszawa 2013. 2. Kasprzak W., Rozpoznawanie obrazów i sygnałów mowy. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2009. 3. Flasiński M., Wstęp do sztucznej inteligencji. Wydawnictwo Naukowe PWN, Warszawa 2018. 4. Giergiel M. J., Hendzel Z., Żylski W., Modelowanie i sterowanie mobilnych robotów kołowych. Wydawnictwo Naukowe PWN, Warszawa 2013. 5. Kaczorek T., Dzieliński A., Dąbrowski W., Łopatka R., Podstawy teorii sterowania. WNT, Warszawa 2005.		
Supplementary references	1. Murphy R. R., Disaster robotics, MIT Press, Cambridge London 2014. 2. Li Z., Ge S. S., Fundamentals in modeling and control of mobile manipulators. CRC Taylor and Francis, 2013. 3. Laugier C. Chatila R. (eds.), Autonomous navigation in dynamic environments. Springer Verlag, Berlin Heidelberg 2010. 4. Gausemeier J., Ramig F. J., Shaffer W. (eds.), Design methodology for intelligent technical systems. Springer Verlag, Berlin Heidelberg 2014. 5. Mazur A., Model-based control for nonholonomic mobile manipulators. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2009.		
Organisational unit conducting the course	Katedra Automatyki i Robotyki	Date of issuing the programme	
Author of the programme	prof. dr hab. inż. Zdzisław Gosiewski	2019-09-23	

Bialystok University of Technology									
Field of study	**Automatic Control and Robotics**							Degree level and programme type	**full-time Master's degree**
Specjalization / diploma path	**computer systems**							Study profile	**general academic**
Course name	**Ethernet industrial networks**							Course code	**MYAR2S22002**
								Course type	**elective**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**2**
	30	**0**	**15**	**15**	**0**	**0**	**0**	No. of ECTS credits	**5**
Entry requirements	-								
Course objectives	Acquainting with IT technologies and principles of operation, design, programming and operation of high-level industrial networks of the Ethernet, PROFINET IO and EtherCAT types. Teaching the basics of PLC network configuration based on the SIMATIC system. Programming functions for real-time data exchange. Performing and testing network configurations with peripheral devices. Education of the principles of diagnostics of industrial networks. Software for IT services in industrial networks.								
Course content	Lecture: Transmission media for Ethernet and OSI model. Basics of Ethernet network operation. TCP / IP protocol. Communication profile and PROFINET IO protocol architecture. Physical layer, cabling and network parameters. Communication in PROFINET IO network: RT, IRT, non-RT mode. Data frames for PROFINET IO networks. Analysis of PROFINET IO network at the protocol level. Programming data exchange in PROFINET IO and EtherCAT networks. Cyclic and acyclic communication. Diagnostics of networks and devices. Programming of IT protocols. Redundant systems. Laboratory: Configuration of the PC station connection with the PROFINET IO system. Assigning IP addresses and naming stations. Configuring the PROFINET IO network, setting the data exchange cycle and the information refresh cycle, configuring the IO devices parameters and the PROFINET IO CBA configuration. IRT configuration of the PROFINET IO network, network topology, configuration of a quick restart of the station in the PROFINET IO network. Programming of cyclic exchange of process data. Performing network diagnostics at the physical layer level and protocol. ARP protocol, listening packet frames in the PROFINET IO network and designing IT functions. Project: Configuration and testing of IT services offered by CP-343 Advanced. Network design with a ring topology. Configuration, programming and testing of industrial SCALANCE S router services and Softnet software. Programming of PROFINET IO diagnostics services at the protocol level using Step7 and the http protocol. Managing station data from the http level. EtherCAT network design. Design of the PROFINET IO / EtherCAT network diagnostics system using frame previews using WireShark software.								
Teaching methods	Informative-problem lecture; Laboratory classes; Project classes;								
Assessment method	Lecture: exam Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes 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
LO1	knows the principle of operation of PROFINET IO network protocols, EtherCAT records, recognizes and is able to properly use communication and control functions in an industrial network	AR2_W03
LO2	knows methods of industrial network diagnostics	AR2_W03 AR2_U01 AR2_U03
LO3	is able to configure, run and test selected industrial networks	AR2_W02 AR2_W05
LO4	can program functions for data exchange in industrial networks and IT services IT	AR2_U03
LO5	uses methods of industrial network diagnostics	AR2_U03
LO6	is ready to critically evaluate content from various sources useful for the design and operation of Ethernet industrial networks	AR2_U03 AR2_U05

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; Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	W L P
LO3	Lecture: exam;	W
LO4	Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	L P
LO5	Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	L P
LO6	Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	L P
LO7	Lecture: exam; Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	W L P

Student workload (in hours)		No. of hours
Calculation	Lecture attendance	30
	Laboratory classes attendance	15
	Project attendance	15
	Preparation for the lecture exam; participation in the exam	16
	Preparation for laboratory classes	12
	Preparation for laboratory classes completion	3
	Preparation for project classes	18
	Working on projects (including preparation of presentations)	6
	Preparation for projects completion	5
	Participation in teacher-student sessions related to the module subject	5
	TOTAL	125

Quantitative indicators	Hours	ECTS
Student workload - activities that require direct teacher participation	67	2,7
Student workload - practical activities	79	3,2

Basic references	1. Mystkowski A., Sieci przemysłowe PROFIBUS DP i PROFINET IO, Oficyna Wydawnicza Politechniki Białostockiej, 2012. 2. Pigan R., Metter M., Automating with PROFINET: Industrial communication based on industrial Ethernet. 2nd Edition, 2015. 3. Ethernet, 2nd ed., Siemens, 2006. 4. Popp M., Weber K., The rapid way to PROFINET, PNO, 2004. 5. Michta E., Modele komunikacyjne sieciowego systemu pomiarowo-sterującego, Wydawnictwo Politechniki Zielonogórskiej, Zielona Góra, 2000.
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. PN EN 61131-3:2004 Sterowniki programowalne: języki programowania. 4. www.profibus.com, www.profibus.org.pl (PNO).

Organisational unit conducting the course	Katedra Automatyki i Robotyki	Date of issuing the programme
Author of the programme	dr hab. inż. Arkadiusz Mystkowski	2019-09-23

Bialystok University of Technology									
Field of study	**Automatic Control and Robotics**							Degree level and programme type	**full-time Master's degree**
Specjalization / diploma path	**computer systems**							Study profile	**general academic**
Course name	**Artificial neural networks and expert systems**							Course code	**MYAR2S22003**
								Course type	**elective**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**2**
	30	**0**	**0**	**0**	**30**	**0**	**0**	No. of ECTS credits	**5**
Entry requirements	-								
Course objectives	Deepening knowledge about architectures and methods of teaching artificial neural networks and their applications in technical problems. Acquaintance with selected methods of optimization of neural network architecture. Understanding basic problems of expert systems synthesis, practical implementation of the expert system using PC Shell class software.								
Course content	Lecture: Self-organizing and competing networks. Advanced structures of neural networks: feedback networks, SVM networks, deep neural networks, neuro-fuzzy networks. Problems of selection and optimization of the architecture of a feeforward neural network. Teaching neural networks using advanced optimization algorithms (including genetic algorithms). Application of neural networks in process control and diagnostic problems. Concept and architecture of expert systems. Knowledge acquisition. Tools for creating expert systems. Examples of expert systems. Hybrid methods. Specialistic workshop: The use of artificial neural networks in tasks: approximation of input-output mappings, pattern recognition, modeling and identification of dynamic systems. The use of networks in the problems of control and diagnostics. Optimization of the neural network architecture using pruning methods. Designing SVM neural networks and neuro-fuzzy networks. Acquaintance with the environment for creating expert systems. Designing and testing the properties of a rule-based expert system.								
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
LO1	lists and describes advanced structures of neural networks, methods of their learning and areas of application of these networks in automatic control and robotics	AR2_W03 AR2_W07
LO2	describes methods of optimization of neural network architecture	AR2_W03 AR2_W07
LO3	cites and presents main issues related to synthesis of expert systems	AR2_W03 AR2_W07
LO4	is able to select and apply an advanced structure of a neural network in a selected technical problem and analyze its operation and performance	AR2_U03 AR2_U04
LO5	can design and teach an artificial neural network with the optimal architecture for a given problem	AR2_U03 AR2_U04
LO6	can design an expert system, evaluate its operation and propose, if necessary, a modification of a system	AR2_U03 AR2_U04

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
Student workload (in hours)		No. of hours

Calculation	Lecture attendance	30	
	Workshop attendance	30	
	Preparation for the lecture exam; participation in the exam	14	
	Preparation of reports from excercises made at the specialistic workshop	46	
	Participation in teacher-student sessions related to the module subject	5	
	TOTAL	125	
Quantitative indicators		Hours	ECTS
Student workload - activities that require direct teacher participation		67	2,7
Student workload - practical activities		81	3,2
Basic references	1. Duch W. i in. (red.), Biocybernetyka i inżynieria biomedyczna 2000, Tom 6 – Sieci neuronowe. Akademicka Oficyna Wydawnicza Exit, Warszawa 2000. 2. Grzech A. i in., Inżynieria wiedzy i systemy ekspertowe. Akademicka Oficyna Wydawnicza EXIT, Warszawa, 2009. 3. Osowski S., Sieci neuronowe do przetwarzania informacji, Oficyna Wydawnicza Politechniki Warszawskiej. Warszawa 2013. 4. Rutkowski L., Metody i techniki sztucznej inteligencji. Wydawnictwo Naukowe PWN, Warszawa, 2009. 5. Kosiński R. A., Sztuczne sieci neuronowe: dynamika nieliniowa i chaos. Wydawnictwo WNT, Warszawa 2014.		
Supplementary references	1. Białko M., Sztuczna inteligencja i elementy hybrydowych systemów ekspertowych. Wydawnictwo Uczelniane Politechniki Koszalińskiej, Koszalin 2005. 2. Markowska-Kaczmar U., Ekstrakcja reguł z sieci neuronowych: podejście ewolucyjne. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2006. 3. Fujarewicz K., Zastosowanie wybranych metod sieci neuronowych w sterowaniu i bioinformatyce. Wydawnictwa Politechniki Śląskiej, Gliwice 2010. 4. Osowski S., Metody i narzędzia eksploracji danych. Wydawnictwo BTC, Legionowo 2013. 5. Tuffery S., Data mining and statistics for decision making. John Wiley and Sons, 2011.		
Organisational unit conducting the course	Katedra Automatyki i Elektroniki	Date of issuing the programme	
Author of the programme	dr hab. inż. Mirosław Świercz, prof. PB	2019-09-23	

Bialystok University of Technology									
Field of study	**Automatic Control and Robotics**							Degree level and programme type	**full-time Master's degree**
Specjalization / diploma path	**computer systems**							Study profile	**general academic**
Course name	**Cooperation of robots**							Course code	**MYAR2S22004**
								Course type	**elective**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**2**
	15	**0**	**0**	**30**	**0**	**0**	**0**	No. of ECTS credits	**4**
Entry requirements	-								
Course objectives	Familiarizing with the issues of cooperation of industrial robots and mobile robots. Introduction to issues related to control of swarms and formations of mobile robots, communication and data exchange in cooperation with robots. Introduction to IT tools used to implement cooperation between robots.								
Course content	Lecture: Calibration methods of robotic cells. Introduction of principles of cooperation of robots, familiarization with methods of control of swarms and formations of mobile robots, issues of communication and data exchange between robots operating in a group. Methods of planning the route for cooperating robots. Project: Modeling of a robotic cell armed with at least two robots and sensors. Calibration of a robotic cell. Implementation of the ROS system package containing the position model, configuration of the work cell and providing the interface necessary to carry out the project task in the simulation using cooperating robots. Designing control laws, algorithms for cooperation, planning, generation and tracking of the route by a group of robots using the ROS / MATLAB / Simulink environment.								
Teaching methods	Informative-problem lecture; Project classes;								
Assessment method	Lecture: one test 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
LO1	knows the methods of work cell calibration	AR2_W07
LO2	knows the basic methods of cooperation of mobile robots and industrial robots	AR2_W03
LO3	knows and understands the principles of design, implementation, operation and optimization of systems consisting of many cooperating robots	AR2_W04 AR2_W07
LO4	can determine the principles of cooperation of many robots, choose parameters for data exchange and model the dynamics of a system consisting of many mobile robots	AR2_U04

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

	Student workload (in hours)	No. of hours
Calculation	Lecture attendance	15
	Project attendance	30
	Preparation for lecture test(s)	14
	Preparation for project classes	18
	Working on projects (including preparation of presentations)	12
	Preparation for projects completion	6
	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		71	2,8
Basic references	1. Lentin J., Mastering ROS for robotics programming. Packt Publishing Ltd, UK, 2015. 2. O'Kane J. M., A gentle introduction to ROS. University of South Karolina, Columbia 2013. 3. Martinez A., Fernandez E., Learning ROS for robotics programming. Packt Publishing Ltd, UK, 2013. 4. Ren W., Beard R. W., Distributed consensus in multi-vehicle cooperative control, theory and applications. Springer-Verlag London, 2008.		
Supplementary references	1. Shamma J., Cooperative control of distributed multi-agent systems. John Wiley&Sons, 2007. 2. Siciliano B., Khatib O., Handbook of robotics, 2nd edition. Springer-Verlag Berlin, 2016.		
Organisational unit conducting the course	Katedra Automatyki i Robotyki	Date of issuing the programme	
Author of the programme	dr inż. Adam Wolniakowski	2019-09-23	

Bialystok University of Technology									
Field of study	**Automatic Control and Robotics**							Degree level and programme type	**full-time Master's degree**
Specjalization / diploma path	**computer systems**							Study profile	**general academic**
Course name	**Intelligent technical systems**							Course code	**MYAR2S22005**
								Course type	**elective**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**2**
	15	**0**	**0**	**30**	**0**	**0**	**0**	No. of ECTS credits	**4**
Entry requirements	-								
Course objectives	Acquainting with intelligent technical systems, with particular emphasis on their use in automation and robotics. Internet of things, use of integrated computer systems to create digital factories, introduction to the issues of machines and robots adapting to the environment, intelligent sensors and materials.								
Course content	Lecture: Introduction to intelligent technical systems, definition, short history, examples of applications. The concept of a smart industrial plant based on the principles of the Internet of Things. Effective search of large databases. Examples of implementations. Digital factory concept. The use of integrated computer systems to create digital factories. Experimental methods of increasing productivity and production efficiency. Introduction to self-learning machines and robots. Examples of industrial self-learning systems. Integration of the machine controller with artificial intelligence algorithms. Smart sensors. Intelligent measuring instruments. Industrial examples of intelligent measuring systems. Measuring self-calibrating devices. Knowledge-based systems. Systems that acquire knowledge automatically from various knowledge resources. Practical examples of systems. Introduction to intelligent materials. Classification of intelligent materials. Piezoelectric materials and their use in the design of vibration energy recovery systems. Project: Development of an intelligent control system for the production line. Scope of the project: introduction of technical devices to programming; development of knowledge-based control (rule modeling, fuzzy controller); development of a self-learning machine system; Integration of the PLC of the machine with artificial intelligence algorithms; algorithm tests on real objects.								
Teaching methods	Informative-problem lecture; Project classes;								
Assessment method	Lecture: one test 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
LO1	knows and understands basic concepts related to intelligent technical systems	AR2_W05 AR2_W07
LO2	knows and understands the principles of the Internet of Things; can point and discuss the application areas of intelligent systems based on the concept of the Internet of Things; knows the tools for digital factory design	AR2_W03 AR2_U01
LO3	knows and understands the structure of machine expert systems, methods of knowledge representation, heuristic control algorithms, the need for machine learning and data mining	AR2_W04 AR2_W05
LO4	knows the principle of operation and types of intelligent sensors	AR2_W02 AR2_W07
LO5	can process and analyze large databases for decision making processes	AR2_U03 AR2_U06
LO6	can integrate the controller machines with an artificial intelligence algorithm	AR2_U04 AR2_U09
LO7	can classify intelligent materials and on their basis, design an energy recovery system	AR2_U02 AR2_U06

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	Lecture: one test;	W

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
Student workload (in hours)		No. of hours
Calculation	Lecture attendance	15
	Project attendance	30
	Preparation for lecture test(s)	14
	Preparation for project classes	18
	Working on projects (including preparation of presentations)	12
	Preparation for projects completion	6
	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	71	2,8

Basic references	1. Rutkowski 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. 4. Ciupke K., Laboratorium metod sztucznej inteligencji z zastosowaniem języka R, Wydawnictwo Politechniki Śląskiej, 2016.

Organisational unit conducting the course	Katedra Automatyki i Robotyki	Date of issuing the programme
Author of the programme	dr inż. Sławomir Romaniuk	2019-09-23

Bialystok University of Technology									
Field of study	**Automatic Control and Robotics**							Degree level and programme type	**full-time Master's degree**
Specjalization / diploma path	**computer systems**							Study profile	**general academic**
Course name	**Automation systems**							Course code	**MYAR2S22006**
								Course type	**elective**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**2**
	30	**0**	**0**	**15**	**0**	**0**	**0**	No. of ECTS credits	**4**
Entry requirements	-								
Course objectives	Familiarizing with the concepts of automation (robotization). Presentation and analysis of selected systems for automation (robotization) of production / industrial processes and automation systems for buildings. Learning procedures of designing systems for automation of production / industrial processes, automation systems for buildings and with creating documentation using computer-aided environments for engineering design.								
Course content	Lecture: Basic concepts: production, production processes, automated processes, automatic processes, automation, automation system, automation and automatic control. Advantages of introducing automation of service, production, industrial processes and automation of buildings. Disadvantages of automation introduction. Technological unemployment. The process of automation of production / industrial processes and automation of buildings. Internet of Things. The use of internet technologies in the automation of homes, cities, enterprises, energy systems, measurement systems, environmental monitoring processes and risk monitoring. Comprehensive automation. Automation tool - programmable logic controllers (PLC). Pneumatic and hydraulic automation systems. Development trends and the latest achievements in the field of automation. Project: Designing systems for automation of service, production, industrial processes and automation systems for buildings. Principles of preparing documentation of the designed automation system using computer-aided environments for engineering design.								
Teaching methods	Informative-problem lecture; Project classes;								
Assessment method	Lecture: two tests 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
LO1	knows the concepts related to automation (robotization) and lists the benefits resulting from the introduction of automation (robotization) of service, production, industrial processes and automation of buildings	AR2_W03
LO2	provides stages and describes the essence of automation of service, production, industrial processes and automation of buildings	AR2_W04
LO3	lists and analyzes exemplary systems for the automation of service, production and industrial processes, automation of buildings and knows the latest development trends in the field of automation	AR2_W07
LO4	can design selected automation systems and can prepare documentation using computer-aided environments for engineering design	AR2_U01 AR2_U02 AR2_U03
LO5	can organize the work of a project team dealing with the automation of a selected process	AR2_U10

Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	Lecture: two tests;	W
LO2	Lecture: two tests;	W
LO3	Lecture: two tests;	W
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

Student workload (in hours)	No. of hours

Calculation	Lecture attendance	30	
	Project attendance	15	
	Preparation for lecture test(s)	17	
	Preparation for project classes	21	
	Working on projects (including preparation of presentations)	6	
	Preparation for projects completion	6	
	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		53	2,1
Basic references	1. Marciniak M., Elementy automatyzacji we współczesnych procesach wytwarzania. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2007. 2. Mikulczyński T., Automatyzacja procesów produkcyjnych: metody modelowania procesów dyskretnych i programowania sterowników PLC. PWN, Wydawnictwo 2, Warszawa, 2017. 3. Mikulczyński T., Samsonowicz Z., Więcławek R., Automatyzacja procesów produkcyjnych. Wydawnictwo Naukowe PWN, Warszawa, 2017. 4. Świder J. (red.), Sterowanie i automatyzacja procesów technologicznych układów mechatronicznych. Układy pneumatyczne i elektropneumatyczne ze sterowaniem logicznym (PLC). Wydawnictwo Politechniki Śląskiej, Gliwice 2015. 5. Kost G., Łebkowski P., Węsierski Ł., Automatyzacja i robotyzacja procesów produkcyjnych. PWE Polskie Wydawnictwo Ekonomiczne. Warszawa, 2013.		
Supplementary references	1. Czasopisma, m.in. Pomiary, Automatyka i Robotyka (PAR); Automatyka; Napędy i sterowanie, internetowe bazy danych Google Scholar, Google Patents, zdalne bazy czasopism naukowych PB, www.intechopen.com 2. Matyszewska E. (red.), Automatyzacja przemysłu spożywczego Casebook. Wydawnictwo Naukowe PWN. Warszawa, 2016. 3. Serwisy internetowe: iAutomatyka.pl, eplan.pl, astor.com.pl, automatykab2b.pl, aps.pl.		
Organisational unit conducting the course	Katedra Automatyki i Robotyki	Date of issuing the programme	
Author of the programme	dr inż. Roman Trochimczuk	2019-09-23	

Bialystok University of Technology									
Field of study	**Automatic Control and Robotics**							Degree level and programme type	**full-time Master's degree**
Specjalization / diploma path	**computer systems**							Study profile	**general academic**
Course name	**Autonomous systems**							Course code	**MYAR2S22007**
								Course type	**elective**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**2**
	30	**0**	**30**	**15**	**0**	**0**	**0**	No. of ECTS credits	**6**
Entry requirements	-								
Course objectives	Familiarization with known solutions of autonomous systems. Explanation of terms: adaptation, redundancy, reconfiguration and synergy. Presentation of sensors used to analyze the state of the environment and the internal state of the system. Discussion of the issues of designing autonomous mobile robots: avoiding obstacles, reconfiguration in case of damage, autonomy of takeoff and landing in case of flying robots, autonomous navigation, trajectory planning.								
Course content	Lecture: Significance and role of processing and analysis of sequence of table measurements in real time. Characteristics of various sources of obtaining image information. Presentation and discussion of methods for motion measurement and estimation. Active motion analysis in the environment as well as techniques and methods of building the environment map (SLAM). Concepts of planning algorithms and generating the trajectory of movement of autonomous mobile objects. Application and integration of multi-stage control algorithms. Autonomous mobile robots - design, modeling, control and analysis of on-board equipment in terms of tasks and implementation of autonomous motion. Reactive navigation. Location of a mobile robot. The use of sensory information to build algorithms for detecting and bypassing obstacles. Designing a diagnostic system to reconfigure the control system in the event of a drive failure. Laboratory: Designing and programming control laws, navigation functions, reactive navigation functions and control algorithms in safe mode and testing them on flying platforms. Project: Modeling of autonomous mobile platforms and simulation of mobile motion of an autonomous robot, designing of advanced functions and algorithms increasing the autonomy level of a mobile robot.								
Teaching methods	Informative-problem lecture; Laboratory classes; Project classes;								
Assessment method	Lecture: two tests Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes 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
LO1	knows and can apply selected sensory methods and methods of image processing and analysis in real time in terms of generating a trajectory of motion for an autonomous object	AR2_W01 AR2_W02
LO2	knows the principles of design, implementation, operation and optimization of autonomous systems and knows how to use them	AR2_W04 AR2_W06
LO3	knows and can model components of the autonomic system, including multi-drive systems, elements ensuring reconfiguration, redundancy and the necessary level of intelligence	AR2_U03 AR2_U04
LO4	can choose the parameters of the autonomous system and model the dynamics of the autonomous system based on a flying robot	AR2_U04
LO5	can design multicriterial control algorithms ensuring autonomy and simulate them in the application to flying robots	AR2_U03
LO6	understands the need to follow the latest literature reports in the field of autonomous systems technology and demonstrates the initiative in the search for innovative construction solutions of the above-mentioned systems	AR2_U09 AR2_K02

Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	Lecture: two tests; Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes; Project: evaluation of project	W L P

	completion, current progress in project completion, discussion and activity during the classes;	
LO2	Lecture: two tests; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	W P
LO3	Lecture: two tests; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	W P
LO4	Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	L P
LO5	Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	L P
LO6	Lecture: two tests;	W
Student workload (in hours)		No. of hours
Calculation	Lecture attendance	30
	Laboratory classes attendance	30
	Project attendance	15
	Preparation for lecture test(s)	17
	Preparation for laboratory classes	14
	Preparation for laboratory classes completion	6
	Preparation for project classes	21
	Working on projects (including preparation of presentations)	6
	Preparation for projects completion	6
	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	80	3,2
Student workload - practical activities	103	4,1

Basic references	1. Gausemeier J., Rammig, F. J., Schäfer W., Design methodology for intelligent technical systems. Springer, 2014. 2. Beard R. W., McLain T. W., Small unmanned aircraft: theory and practice. Princeton University Press, 2012. 3. Corke P., Robotics vision and control. Second Edition, Springer, 2017. 4. Sonka M., Hlavac V., Boyle R., Image processing, analysis and machine vision, 2014. 5. Valavanis, Kimon P., Vachtsevanos George J., Handbook of robotics. Springer-Verlag Gmbh, 2008.
Supplementary references	1. Bovik A., Handbook of image and video processing. Academic Press; 1st edition (June 14, 2000), lub Academic Press; 2 edition (June 21, 2005). 2. R. Szeliski, Computer vision: algorithms and applications. Springer 2010. 3. Gupta S.,Autonomous robots and agents. Springer, 2007. 4. Fahimi Farbod, Autonomous robots modeling, path planning, and control. Springer, 2009. 5. Azad Pedram, Visual perception for manipulation and imitation in humanoid robots. Springer, 2009.

Organisational unit conducting the course	Katedra Automatyki i Robotyki	Date of issuing the programme
Author of the programme	dr inż. Leszek Ambroziak	2019-09-23