Bialystok University of Technology									
Field of study	**Automatic Control and Robotics**							Degree level and programme type	**full-time Master's degree**
Specjalization / diploma path	**common subject**							Study profile	**general academic**
Course name	**Optimization methods**							Course code	**MYAR2S01001**
								Course type	**obligatory**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**1**
	30	**0**	**0**	**15**	**0**	**0**	**0**	No. of ECTS credits	**3**
Entry requirements	-								
Course objectives	Introduction to basic methods of optimization and calculus of variations. Application of optimization methods in solving simple problems occurring in automatic control and robotics.								
Course content	Lectures and classes: Global and local minimum. Necessary and sufficient conditions for the existence of minimia. Linear and nonlinear programming. Constrained and unconstrained optimization. Numerical methods of optimization: gradient methods, pattern search methods and evolutionary methods. Introduction to multi-criterion optimization. Pareto optimum. Application of calculus of variations: Pontryagin's principle, time-optimal control.								
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 and understands basic concepts of optimization and the concept of calculus variation	AR2_W01
LO2	can propose the right algorithm to solve simple optimization tasks	AR2_W01 AR2_U02
LO3	knows and can use the methods of variation calculus to solve simple optimization problems	AR2_W01 AR2_U02
LO4	is ready to analyze and interpret necessary information from various sources	AR2_K01

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; 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	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)	7
	Preparation for project classes	9
	Working on projects (including preparation of presentations)	6
	Preparation for projects completion	3
	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	38	1,5

Basic references	1. McQuarrie D. A., Matematyka dla przyrodników i inżynierów. Wydawnictwo Nauk0owe PWN, Warszawa 2018.

	2. Kusiak J., Optymalizacja. Wydawnictwo Naukowe PWN, Warszawa 2009. 3. Tarnowski W., Optymalizacja i polioptymalizacja w mechatronice. Wydawnictwo Politechnki Koszalińskiej, Koszalin 2011.	
Supplementary references	1. Górecki H., Optymalizacja i sterowanie systemów dynamicznych. Wydawnictwo AGH, Kraków 2006. 2. Stadnicki J., Teoria i praktyka rozwiązywania zadań optymalizacji. Wydanictwo Naukowe PWN, Warszawa 2017.	
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	**common subject**							Study profile	**general academic**
Course name	**Control theory**							Course code	**MYAR2S01002**
								Course type	**obligatory**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**1**
	30	**30**	**0**	**15**	**0**	**0**	**0**	No. of ECTS credits	**6**
Entry requirements	-								
Course objectives	Acquainting with control plants models (continuous and discrete-time) in the state space, design of regulators and state observers. Developing the ability to use simulation software for the analysis and synthesis of control systems in the state space.								
Course content	Lecture: Model of the control plant in the state space: transfer function and state space models, continuous models and discrete models, solution of the state equation, canonical forms, transformation of state space model to its canonical forms, controllability and observability, stability. Pole placement method. State controller, state observer. Optimal control methods: LQR linear-quadratic regulator, Kalman filter (observer), LQG control system. Classes: State space and transfer function models - transformations; canonical forms; controllability and observability; calculation of the state regulator; calculation of the state observer. Project: Simulation study of selected automation plants, design and testing of the PID control system, design of the state controller, design of the state observer, simulation tests of the LQG control system.								
Teaching methods	Informative-problem lecture; Classes; Project classes;								
Assessment method	Lecture: exam Classes: 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 and understands the concept of the state space model	AR2_W01 AR2_W03
LO2	knows and understands the method of poles placement in the design of the state controller and state observer	AR2_W01 AR2_W03 AR2_W05
LO3	knows selected methods of optimal control	AR2_W01 AR2_W03 AR2_W05
LO4	can use the method of poles placement to determine the controller and the state observer	AR2_U01 AR2_U03
LO5	can design the optimal LQG control system	AR2_U01 AR2_U03
LO6	can use the MATLAB / Simulink software to determine canonical forms, PID controller gains, the state controller and the llinear-gaussian controller, the state observer and Kalman filter	AR2_U01 AR2_U03 AR2_U06

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	Classes: two tests; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	C P
LO5	Classes: two tests; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	C P
LO6	Classes: two tests; Project: evaluation of project completion, current progress in project completion, discussion and activity during the classes;	C P

Student workload (in hours)		No. of hours
Calculation	Lecture attendance	30
	Classes attendance	30

	Project attendance	15
	Preparation for the lecture exam; participation in the exam	19
	Preparation for classes	11
	Preparation for classes completion	6
	Preparation for project classes	21
	Working on projects (including preparation of presentations)	6
	Preparation for projects completion	7
	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	82	3,3
Student workload - practical activities	101	4

Basic references	1. Gosiewski Z., Siemieniako F., Automatyka. Tom 1. Modelowanie i symulacja układów, Tom 2. Synteza układów. Wydawnictwo Politechniki Białostockiej, Białystok 2007. 2. Kaczorek T., Dzieliński A., Dąbrowski W., Łopatka R., Podstawy teorii sterowania. WNT, Warszawa 2005. 3. Ogata K., Modern control engineering. 4th Edition. Pearson Education International 2002. 4. Jędrzykiewicz Z., Teoria sterowania układów jednowymiarowych. Wydawnictwo AGH, Kraków 2007.
Supplementary references	1. Dorf R. C., Bishop R. H., Modern control systems. 10th Edition. Prentice Hall 2005. 2. Tewari A., Modern control design: with MATLAB and Simulink. Wiley-IEEE Press 2001. 3. Bequette B. W., Process control, modeling, design and simulation. Prentice Hall 2003. 4. The MathWorks. Control system toolbox user's guide.

Organisational unit conducting the course	Katedra Automatyki i Robotyki	Date of issuing the programme
Author of the programme	dr hab. inż. Zbigniew Kulesza, 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	**common subject**							Study profile	**general academic**
Course name	**Real time controllers**							Course code	**MYAR2S01003**
								Course type	**obligatory**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**1**
	15	**0**	**0**	**30**	**0**	**0**	**0**	No. of ECTS credits	**4**
Entry requirements	-								
Course objectives	Acquainting with ARM (Advanced RISC Machine) architecture supporting the implementation of real-time controllers. Learning how to realize a real-time controller on the example of the STM32 microprocessor. Familiarizing with the role of interrupts in ARM architecture and in real time controllers. Presentation of peripherals necessary to implement real-time controllers. Familiarization with power management modes of the ARM based system. Learning the rules of real-time control and the structure of the FreeRTOS operating system. Learning the components of the real-time control system such as: semaphores, queues, mutexes, tasks and co-programs. Getting to know and implementing the real-time control system on the example of FreeRTOS.								
Course content	Lecture: Definition, classification and features of the real-time control system. Examples of real-time controllers and embedded systems. ARM architecture and its features supporting real-time operating systems e.g. bitbanding technique. Elements of microcontrollers used to implement real-time control systems. Multilevel interrupt system and its application on the example of STM32 microcontroller. DMA technology and its use in real time controllers. FreeRTOS real time system, its characteristics, code structure, creating, managing and deleting tasks. Semaphores, queue mutexes, tasks, co-programs, task manager in the FreeRTOS system. Hooked functions, exceptions, task priorities, task blocking, task context and its switching. Differences between tasks and co-programs. Application of CLI library to manage operation of a system based on FreeRTOS. Project: Implementation of sample control applications using the ZL27ARM set. Examples of real-time control applications with the FreeRTOS system. Development and implementation of a simple control system based on FreeRTOS.								
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 properties of the real-time control system	AR2_W03
LO2	knows and understands the role of interrupts, DMA and power management modes in real time controllers	AR2_W03 AR2_W05
LO3	understands the basics of real-time control systems and knows the role of semaphores, mutexes, queues, tasks and co-programs in their operation	AR2_W03 AR2_W05
LO4	is able to design and implement the controller using STM32 microprocessor and FreeRTOS system	AR2_U03 AR2_U04 AR2_W04
LO5	knows and explains the operation of the real-time controller	AR2_U03 AR2_U04 AR2_U05
LO6	can use the documentation and technical specifications (also in English)	AR2_U01 AR2_U02

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	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	
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. Paprocki K., Mikrokontrolery STM32 w praktyce. Wydawnictwo BTC, 2009. 2. Galewski M., STM32, aplikacje i ćwiczenia w języku C. Wydawnictwo BTC, 2011. 3. Peczarski M., Mikrokontrolery STM32 w sieci Ethernet w przykładach. BTC, 2011. 4. Furber S., ARM system on chip architecture. Addison-Wesley, 2000. 5. Yiu J., The definite guide to the ARM Cortex-M3. Newnes, 2009.		
Supplementary references	1. Bryndza L., Mikrokontrolery z rdzeniem ARM w przykładach. BTC, 2009. 2. Barr M., Programming embedded systems with C and GNU development tools. O'Reilly, 2006. 3. Hohl W., ARM assembly language: fundamentals and techniques. CRC, 2009. 4. http://www.freertos.org/		
Organisational unit conducting the course	Katedra Automatyki i Robotyki	Date of issuing the programme	
Author of the programme	dr inż. Cezary Kownacki	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	**common subject**							Study profile	**general academic**
Course name	**Artificial intelligence systems**							Course code	**MYAR2S01004**
								Course type	**obligatory**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**1**
	30	**0**	**0**	**0**	**15**	**0**	**0**	No. of ECTS credits	**3**
Entry requirements	-								
Course objectives	Familiarizing with basic tools of artificial intelligence and their application in automatic control and robotics. Developing skills in implementing basic artificial intelligence algorithms in a simulation environment, used to solve engineering problems in automatic control and robotics.								
Course content	Lecture: Basic concepts, terms and areas of application of artificial intelligence. Turing test. Methods of knowledge representation and inference in artificial intelligence systems. Classification. Basic classification methods, types of classifiers and methods for assessing the quality of classifiers. Artificial neuron models, basic structures of neural networks: feedforward networks, networks with radial basis functions, self-organizing networks. Applications of neural networks: approximation, prediction, classification, signal processing, modeling of system dynamics. Fuzzy sets and relations, fuzzy models, fuzzy pattern recognition, classification and control systems. Construction methodology for fuzzy models and fuzzy control systems. Basic concepts of genetic algorithms - genetic operations, selection methods, population models. Applications of genetic algorithms. Specialistic workshop: Application of MLP and RBF neural networks for approximation of input-output mapping and classification of data sets. Solving problems of classification of features and patterns, using selected types of classifiers. Creating fuzzy approximators of static mappings and fuzzy models of dynamic systems. Dynamic system control by means of fuzzy systems. Application of genetic algorithms in static optimization tasks.								
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
LO1	lists and describes main methods and algorithms of artificial intelligence and areas of their application in automatic control and robotics	AR2_W03 AR2_W07
LO2	describes and explains basic methods of classifying data sets and features used to solve engineering problems in automatic control and robotics	AR2_W03 AR2_W07
LO3	can choose and apply the appropriate method of artificial intelligence to solve the problem	AR2_U03 AR2_U04
LO4	designs, teaches and evaluates the operation of selected artificial neural network architectures	AR2_U03 AR2_U04
LO5	can develop a fuzzy model of an automatic control or robotics system	AR2_U03 AR2_U04
LO6	can apply a genetic algorithm to search for the optimal solution to an engineering problem in automatic control and robotics	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: one test;	W
LO2	Lecture: one test;	W
LO3	Specialistic workshop: evaluation of reports, individual progress, discussion and activity at workshop;	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
LO6	Specialistic workshop: evaluation of reports, individual progress, discussion	Ps

	and activity at workshop;		
Student workload (in hours)		No. of hours	
Calculation	Lecture attendance	30	
	Workshop attendance	15	
	Preparation for lecture test(s)	5	
	Preparation of reports from excercises made at the specialistic workshop	20	
	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		40	1,6
Basic references	1. Wawrzyński P., Podstawy sztucznej inteligencji. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2014. 2. Osowski S., Sieci neuronowe do przetwarzania informacji (wyd. 3 popr.). Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2013. 3. Flasiński M., Wstęp do sztucznej inteligencji. Wydawnictwo Naukowe PWN, Warszawa 2018. 4. Rutkowski L., Metody i techniki sztucznej inteligencji: inteligencja obliczeniowa (wyd. 2 zm., 3 dodr.). PWN, Warszawa 2012.		
Supplementary references	1. Piegat A., Modelowanie i sterowanie rozmyte. Akademicka Oficyna Wydawnicza EXIT, Warszawa 1999. 2. Goldberg D. E., Algorytmy genetyczne i ich zastosowania. WNT, Warszawa 2003. 3. Morzy T., Eksploracja danych: metody i algorytmy. Wydawnictwo Naukowe PWN, Warszawa 2013. 4. Russell S. J. and Norvig P., Artificial intelligence: a modern approach. Pearson Education, Boston 2010. 5. Szeliga M., Data science i uczenie maszynowe. Wydawnictwo Naukowe PWN, Warszawa 2017.		
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	**common subject**							Study profile	**general academic**
Course name	**Signal and image processing**							Course code	**MYAR2S01005**
								Course type	**obligatory**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**1**
	30	**0**	**30**	**0**	**0**	**0**	**0**	No. of ECTS credits	**5**
Entry requirements	-								
Course objectives	Acquiring knowledge in the field of selected methods needed to describe, analyze and apply signal and image processing and data compression algorithms. Gaining the skills to apply appropriate software tools.								
Course content	Lecture: Filters with finite impulse response and filters with infinite impulse response. Adaptive filtration. Analog-to-digital and digital-to-analog conversion. Non-linear digital filters. Digital image. Acquisition of digital images. Arithmetic and logic operations on digital images. Geometric transformations on digital images. Distorting digital images. Digital image filtration (high pass, low pass, edge, contour, median filters). Frequency methods of image processing. Filtration in the field of frequency. Techniques of color image processing. Histogram and operations on the histogram. Binarization. Morphological transformations of binary images. Lossless algorithms and lossless data compression. Discrete cosine transformation and its application for image compression. JPEG algorithm. Compression of moving images. Algorithms used in sound and speech compression. Review of standards for recording graphic and audio files. Laboratory: Design of digital filters with finite and infinite impulse response. Linear image filtration. Arithmetic, logical and geometric operations on the image, image distortion. Binarization, morphological operations. Non-linear filtering of images. Processing of color images.								
Teaching methods	Informative-problem lecture; Laboratory classes;								
Assessment method	Lecture: two tests 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 advanced methods of signal and image processing								AR2_W02
LO2	can choose and use advanced methods of signal and image processing								AR2_U03
LO3	can use computer tools used to process signals and images								AR2_U03
LO4	is ready to analyze and critically evaluate the received results of signal/image processing								AR2_K01
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	Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes;								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
Student workload (in hours)									No. of hours
Calculation	Lecture attendance								30
	Laboratory classes attendance								30
	Preparation for lecture test(s)								30
	Preparation for laboratory classes								24
	Preparation for laboratory classes completion								6
	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		65	2,6
Basic references	1. Zieliński T., Cyfrowe przetwarzanie sygnałów. Od teorii do zastosowań, WKŁ, Warszawa 2009. 2. Lyons R. , Wprowadzenie do cyfrowego przetwarzania sygnałów. WKŁ, Warszawa, 2010. 3. Smith S. W., Cyfrowe przetwarzanie sygnałów. Praktyczny poradnik dla inżynierów i naukowców. Wydawnictwo BTC, Legionowo, 2007. 4. Przelaskowski A., Kompresja danych: podstawy, metody bezstratne, kodery obrazów. Wydawnictwo BTC, Warszawa, 2005. 5. Malina W., Smiatacz M., Cyfrowe przetwarzanie obrazów. Akademicka Oficyna Wydawnicza EXIT, Warszawa, 2008.		
Supplementary references	1. Schilling R. J., Harris S. L., Introduction to digital signal processing using MATLAB. Cengage Learning, 2012. 2. Yun Q. Shi, Huifang Sun, Image and video compression for multimedia engineering - fundamentals, algorithms and standards. CRC Press, 2000.		
Organisational unit conducting the course	Katedra Automatyki i Robotyki	Date of issuing the programme	
Author of the programme	dr hab. inż. Jolanta Pauk, 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	**common subject**							Study profile	**general academic**
Course name	**Control systems for robots**							Course code	**MYAR2S01006**
								Course type	**obligatory**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**1**
	15	**0**	**30**	**0**	**0**	**0**	**0**	No. of ECTS credits	**4**
Entry requirements	-								
Course objectives	Introduction to the methods of modelling, control and simulation of robots with the use of the Robot Operating System.								
Course content	Lecture: Basic concepts and principles of ROS. Communication in ROS. Creating packages and nodes in ROS. Creating and customizing ROS messages, services and actions. Introduction to ROS tools: rosbag, rqt, rviz, roslaunch. Laboratory: Modelling and simulation of robots in Gazebo. Implementing ROS packages to control robots of specified configuration.								
Teaching methods	Informative-problem lecture; Laboratory classes;								
Assessment method	Lecture: exam 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 the concepts and principles of ROS	AR2_W04 AR2_W05 AR2_W07
LO2	can implement packages and nodes utilizing ROS communication	AR2_U03
LO3	knows and can use ROS tools	AR2_W04 AR2_U03
LO4	can model and simulate robots in Gazebo environment; can implement ROS control of robots of specified configuration	AR2_U02 AR2_U03

Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	Lecture: exam; Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes;	W L
LO2	Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes;	L
LO3	Lecture: exam; Laboratory: evaluation of introductory tests, reports, discussion and activity during the classes;	W L
LO4	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 the lecture exam; participation in the exam	25
	Preparation for laboratory classes	19
	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	52	2,1
Student workload - practical activities	60	2,4

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.
Supplementary references	1. ROS documentation. 2. Gazebo documentation.

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	**common subject**							Study profile	**general academic**
Course name	**Identification of control systems**							Course code	**MYAR2S01007**
								Course type	**obligatory**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**1**
	30	**0**	**0**	**15**	**0**	**0**	**0**	No. of ECTS credits	**3**
Entry requirements	-								
Course objectives	Gaining theoretical and practical knowledge in the field of design and analysis of linear and non-linear models of control plants based on data obtained during active and passive experiments.								
Course content	Lecture: Linear and nonlinear control plants subject to identification. Parametric and nonparametric methods used for identification. Models of the considered methods and their uncertainties. Modeling errors. Parameterization of plant models based on time and frequency methods, including the LMFD, RMFD and Markov parameters. Verification of estimated models. Recursive methods for estimation of model parameters. Adaptive models. Model testing. Project: Project implementation based on obtained experimental data using the methods discussed in the lecture.								
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 and understands methods of identification of control plants	AR2_W03
LO2	knows methods of verification of models used in identification of control plants	AR2_W03 AR2_W05
LO3	can identify linear control plants	AR2_U02 AR2_U06
LO4	can identify non-linear control plants	AR2_U02 AR2_U06
LO5	can present a control plant subject to identification and present results of conducted analyzes	AR2_U02 AR2_U05

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	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

Student workload (in hours)		No. of hours
Calculation	Lecture attendance	30
	Project attendance	15
	Preparation for lecture test(s)	7
	Preparation for project classes	9
	Working on projects (including preparation of presentations)	6
	Preparation for projects completion	3
	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	38	1,5

Basic references	1. Soderstrom T., Stoica P., Identyfikacja systemów. PWN, Warszawa, 2001. 2. Horla D., Królikowski A., Identyfikacja obiektów sterowania. Metody dyskretne. Wydawnictwo Politechniki Poznańskiej, Poznań, 2005. 3. Zimmer A., Englot A., Identyfikacja obiektów i sygnałów: teoria i praktyka dla użytkowników MATLABa: Politechnika Krakowska, Kraków 2005.	
Supplementary references	1. Janiszowski K., Identyfikacja modeli parametrycznych w przykładach. Wydawnictwo Exit, Warszawa 2002. 2. Manerowski J., Identyfikacja modeli dynamiki ruchu sterowanych obiektów latających. Wydawnictwo Naukowe ASKON, Warszawa 1999. 3. System identification toolbox. Przewodnik firmy Machorka, 2017. 4. Ljung L., System identification: a theory for the user. 2nd ed. Upper Saddle River, NJ: Prentice Hall, 1998. ISBN: 0136566952.	
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	**common subject**							Study profile	**general academic**
Course name	**Foreign language English (B2+)**							Course code	**MYAR2S01008**
								Course type	**elective**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**1**
	0	**30**	**0**	**0**	**0**	**0**	**0**	No. of ECTS credits	**2**
Entry requirements	-								
Course objectives	Deepening the proficiency of English speaking - preparing and delivering presentations and conducting discussions. Creating complex texts, using and giving opinions on foreign language source information in the field of the field of studies.								
Course content	Topics: New technologies, innovations, procedures and research methods, organization and presentation of own research work. Grammar: present and past tenses, useful syntax categories, combining subordinate sentences.								
Teaching methods	Classes;								
Assessment method	Evaluation of inter-semester tests; mofular tests, written and oral statements, reports and presentations								

Symbol of learning outcome	Learning outcomes	Reference to the learning outcomes for the field of study
LO1	understands and creates complex texts in English related to the field of study, in accordance with the requirements set for the B2+ level of the European Language Description System	AR2_U09
LO2	reads comprehensively catalog cards, application notes, equipment manuals, etc. documents in English, according to the requirements for the level B2+ European Language Description System	AR2_U09
LO3	uses English language in accordance with the requirements set for the B2+ level of the European System of Language Description	AR2_U09
LO4	can prepare and present an oral presentation in English on a selected topic related to the field of study and lead a discussion about the presentation	AR2_U09

Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	Evaluation of inter-semester tests; mofular tests, written and oral statements, reports and presentations;	C
LO2	Evaluation of inter-semester tests; mofular tests, written and oral statements, reports and presentations;	C
LO3	Evaluation of inter-semester tests; mofular tests, written and oral statements, reports and presentations;	C
LO4	Evaluation of inter-semester tests; mofular tests, written and oral statements, reports and presentations;	C

Student workload (in hours)		No. of hours
Calculation	Classes attendance	30
	Preparation for classes	9
	Preparation for classes completion	6
	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. McCarthy M., O'Dell F., Academic Vocabulary in Use, Cambridge University Press, 2016 2. Stephenson H., Lansford L, Dummet P., Keynote TEDTalks Upper-Intermediate, National Geographic

	Learning, 2015. 3. Materiały własne lektora oraz materiały dodatkowe z Internetu.	
Supplementary references	1. Bonamy D., Technical English 4. Pearson Longman, 2011. 2. Ibbotson M., Professional English in Use - Engineering, Cambridge University Press, 2009. 3. Downes C., Cambridge English for Job Hunting, Cambridge University Press, 2008.	
Organisational unit conducting the course	Studium Języków Obcych	Date of issuing the programme
Author of the programme	mgr Tomasz Lange	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	**common subject**							Study profile	**general academic**
Course name	**Foreign language English**							Course code	**MYAR2S01009**
								Course type	**elective**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**1**
	0	**30**	**0**	**0**	**0**	**0**	**0**	No. of ECTS credits	**2**
Entry requirements	-								
Course objectives	Improving the knowledge of English grammar in written work. Getting to know the vocabulary of English which enables communication in specific typical situations, including work environment. Ability to read technical documentation and interpretation of basic information from foreign literature concerning the studied field.								
Course content	Topics: Work / career. Security. Planning. Properties and features of materials used in technological processes, structure and operation of selected devices. Grammar: Present Continuous, Present Simple and structure be going to. The degree of the higher adjective and the ways of comparing items. Present Perfect and Past Simple. Modal verbs - active and passive. Forms of verbs after the terms: if / when / after / until / unless / without / before. Creating questions. Predicting the future: will + be able to, have to, need to; modal verbs must / can / can not, have to / do not have to.								
Teaching methods	Classes;								
Assessment method	Evaluation of inter-semester tests; mofular tests, written and oral statements, reports and presentations								

Symbol of learning outcome	Learning outcomes	Reference to the learning outcomes for the field of study
LO1	knows and can apply the grammatical rules of English in written works	AR2_U09
LO2	reads with understanding and writes in English texts related to the field of studies	AR2_U09
LO3	knows basic components of selected automatic control and robotics systems	AR2_U09
LO4	uses English sufficiently to communicate in specific situations	AR2_U02 AR2_K01
LO5	can acquire, analyze and interpret information from literature, including scientific literature, in English	AR2_U09

Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	Evaluation of inter-semester tests; mofular tests, written and oral statements, reports and presentations;	C
LO2	Evaluation of inter-semester tests; mofular tests, written and oral statements, reports and presentations;	C
LO3	Evaluation of inter-semester tests; mofular tests, written and oral statements, reports and presentations;	C
LO4	Evaluation of inter-semester tests; mofular tests, written and oral statements, reports and presentations;	C
LO5	Evaluation of inter-semester tests; mofular tests, written and oral statements, reports and presentations;	C

Student workload (in hours)		No. of hours
Calculation	Classes attendance	30
	Preparation for classes	9
	Preparation for classes completion	6
	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. Bonamy D., Technical English 3 -Course Book. Pearson Longman, 2011. 2. Jacques Ch., Technical English 3.- Workbook. Pearson Longman, 2011. 3. Materiały własne lektora oraz materiały z Internetu.		
Supplementary references	1. Bonamy D., Technical English 2. Pearson Longman, 2008. 2. Bonamy D., Technical English 4. Pearson Longman, 2011. 3. Ibbotson M., Professional English in use - engineering. Cambridge University Press, 2009. 4. McCarthy M., O'Dell F., Academic vocabulary in use. Cambridge University Press, 2016. 5. Downes C., Cambridge English for job hunting. Cambridge University Press, 2008.		
Organisational unit conducting the course	Studium Języków Obcych	Date of issuing the programme	
Author of the programme	mgr Halina Bramska	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	**common subject**							Study profile	**general academic**
Course name	**Foreign language Russian**							Course code	**MYAR2S01010**
								Course type	**elective**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**1**
	0	**30**	**0**	**0**	**0**	**0**	**0**	No. of ECTS credits	**2**
Entry requirements	-								
Course objectives	Improving the efficiency of speaking Russian. Increasing the knowledge of lexis in the field of automatic control and robotics and general technical issues. Getting to know the vocabulary of the Russian language that enables communication in specific typical situations, including the work environment. Preparation and presentation of presentations and conducting discussions. Creating complex texts - using and giving opinions on foreign language source information about the field of studies.								
Course content	Topics: Business correspondence. Business meetings, negotiations. Specialist lexics. Grammatical issues: Reconstruction of known morphological and syntactic structures on the basis of the discussed texts.								
Teaching methods	Classes;								
Assessment method	Evaluation of written tests, homeworks, discussions at classes								

Symbol of learning outcome	Learning outcomes	Reference to the learning outcomes for the field of study
LO1	can use selected language structures in both written and oral statements	AR2_U09
LO2	reads with understanding the documents in the field of the studied specialty in Russian, in accordance with the requirements set for the B2+ level of the European Language Description System	AR2_U09
LO3	uses Russian language, in accordance with the requirements set for the B2+ level of the European Language Description System	AR2_U09
LO4	is able to prepare and present an oral presentation in Russian on a chosen topic related to the field of study and lead a discussion about the presentation	AR2_U02 AR2_U08 AR2_U09

Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	Evaluation of written tests, homeworks, discussions at classes;	C
LO2	Evaluation of written tests, homeworks, discussions at classes;	C
LO3	Evaluation of written tests, homeworks, discussions at classes;	C
LO4	Evaluation of written tests, homeworks, discussions at classes;	C

Student workload (in hours)		No. of hours
Calculation	Classes attendance	30
	Preparation for classes	9
	Preparation for classes completion	6
	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. Fast L., Zwolińska M., Biznesmeni mówią po rosyjsku. Русский язык в деловой среде. Dla zaawansowanych.Продвинутый уровень. Poltext, Warszawa, 2005. 2. Kuzmina I., Śliwińska B., Język rosyjski. 365 zadań i ćwiczeń z rozwiązaniami. Langenscheid, Warszawa, 2008. 3. Mroczek T., Русская коммерческая корреспонденция. Dolnośląskie Wydawnictwo Edukacyjne, Wrocław, 2009. 4. Teksty specjalistyczne z Internetu, książek rosyjskich.
Supplementary	1. Kowalska N., Samek D., Praktyczna gramatyka języka rosyjskiego. REA, Warszawa, 2004.

references	2. Kuca Z., Język rosyjski dla średniozaawansowanych. WSiP, Warszawa, 2007. 3. Materiały z rosyjskojęzycznych portali internetowych, prasy i książek. 4. Rozmówki biznesowe. Język rosyjski. Langenscheidt, Warszawa, 2003. 5. Słownik naukowo-techniczny rosyjsko-polski. Wydawnictwa Naukowo-Techniczne, Warszawa, 2009.	
Organisational unit conducting the course	Studium Języków Obcych	Date of issuing the programme
Author of the programme	mgr Irena Kamińska	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	**common subject**							Study profile	**general academic**
Course name	**Foreign language German**							Course code	**MYAR2S01011**
								Course type	**elective**
Forms and number of hours of tuition	L	C	LC	P	SW	FW	S	Semester	**1**
	0	**30**	**0**	**0**	**0**	**0**	**0**	No. of ECTS credits	**2**
Entry requirements	-								
Course objectives	Improving the efficiency of speaking German. Extending knowledge of lexis in the field of automatic control and robotics and general technical issues. Preparation and presentation of presentations and conducting discussions. Creating complex texts, using and giving opinions on foreign language source information in the field of the field of studies.								
Course content	Communication in the work environment. Presentation of a selected topic regarding the fields of studies. Specialist lexics based on a selected scientific article. Strengthening language structures based on the didactic materials used.								
Teaching methods	Classes;								
Assessment method	Evaluation of written tests, homeworks, discussions at classes								

Symbol of learning outcome	Learning outcomes	Reference to the learning outcomes for the field of study
LO1	is able to use selected language structures in oral and written statements	AR2_U09
LO2	understands and creates complex texts in German related to knowledge of the specialty studied, in accordance with the requirements set for the B2+ level of the European System of Language Description	AR2_U02 AR2_U09
LO3	reads with understanding the documents in the field of the studied specialty in German language, in accordance with the requirements set for the B2+ level of the European System of Language Description	AR2_U09
LO4	uses German language, in accordance with the requirements set for the B2+ level of the European System of Language Description	AR2_U09
LO5	can prepare and present oral presentations in German on a selected topic related to the field of study and lead discussion about the presentation	AR2_U02 AR2_U08 AR2_U09

Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed
LO1	Evaluation of written tests, homeworks, discussions at classes;	C
LO2	Evaluation of written tests, homeworks, discussions at classes;	C
LO3	Evaluation of written tests, homeworks, discussions at classes;	C
LO4	Evaluation of written tests, homeworks, discussions at classes;	C
LO5	Evaluation of written tests, homeworks, discussions at classes;	C

Student workload (in hours)		No. of hours
Calculation	Classes attendance	30
	Preparation for classes	9
	Preparation for classes completion	6
	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. Perlmann-Balme M., Schwalb S., Matussek M., Sicher! Deutsch als Fremdsprache: Niveau B2: Kursbuch und Lektion 1-12, München, Hueber Verlag, 2014. 2. Maria S., Heiner D., Deutsch für Ingenieure, Springer Vieweg 2014. 3. Kuhn Ch., Niemann R. M., Winzer-Kiontke B., Studio d - Die Mittelstufe B2, Cornelsen Verlag 2010.

	4. Hagner V., Schlüter S., Im Beruf Kurs- und Arbeitsbuch, Hueber Verlag 2014. 5. Materiały własne prowadzącego (adaptowane i opracowane teksty z literatury fachowej oraz z Internetu).	
Supplementary references	1. Omelianiuk W., Ostapczuk H., Sach- und Fachtexte auf Deutsch, Teil 2, Politechnika Białostocka, Białystok, 2010. 2. Sokołowska M., Bender A., Żak K. (red.), Słownik naukowo-techniczny niemiecko-polski, Wydawnictwa Naukowo-Techniczne 2007. 3. Perlmann-Balme M., Schwalb S., Matussek M., Sicher! C1 Kurs- und Arbeitsbuch, Hueber Verlag GmbH, 2015.	
Organisational unit conducting the course	Studium Języków Obcych	Date of issuing the programme
Author of the programme	mgr Wioletta Omelianiuk	2019-09-23