Zał. Nr 2 do ZW 25/2019

ASSUMED LEARNING OUTCOMES

FACULTY: **Electrical Engineering**

MAIN FIELD OF STUDY: **Industrial Control Engineering**

EDUCATION LEVEL: ~~first-level (licencjat/inżynier) studies~~ / second-level studies / ~~magister uniform studies~~*

PROFILE: general academic / ~~practical~~ *

Location of the main-field-of study:

Branch of science: Engineering and technology

Discipline / disciplines (for several disciplines, please indicate the major discipline)

automation, electronics and electrical engineering

Explanation of the markings:
P7U – universal first degree characteristics corresponding to education at the second-level studies - 7 PRK level *
P7S – second degree characteristics corresponding to education at the second-level studies - 7 PRK level *
W - category "knowledge"
U - category "skills"
K - category "social competences"
K2APR_W1, K2APR_W2, K2APR_W3, … - main-field-of study learning outcomes related to the category "knowledge"
K2APR_U1, K2APR_U2, K2APR_U3, … - main-field-of study learning outcomes related to the category "skills"
K2APR_K1, K2APR_K2, K K2APR_K3, … - main-field-of study learning outcomes related to the category "social competences"

Specialization Automation of Machines, Vehicles and Apparatus
S2AMPU_W1, S2AMPU_W2, S2AMPU_W3… - specialization learning outcomes related to the category "knowledge"
S2AMPU_U1, S2AMPU_U2, S2AMPU_U3, … - specialization learning outcomes related to the category "skills"
… _inż. – learning outcomes related to the engineer competences
Specialization Automation and Control in Electrical Power Systems
S2ASE_W1, S2ASE_W2, S2ASE_W3, … - specialization learning outcomes related to the category "knowledge"
S2ASE_U1, S2SE_U2, S2ASE_U3… - specialization learning outcomes related to the category "skills"
… _inż. – learning outcomes related to the engineer competences

* delete as applicable

Main field of study learning outcomes	Description of learning outcomes for the main-field-of study **Industrial Control Engineering**	Reference to PRK characteristics		
		Universal first degree characteristics (U)	Second degree characteristics typical for qualifications obtained in higher education (S)	
			Characteristics for qualifications on ~~6 /~~ 7* levels of PRK	Characteristics for qualifications on ~~6 and~~ 7 levels of PRK, enabling acquiring engineering competences
KNOWLEDGE (W)				
K2APR_W1	he knows the fundamental terms, definitions and theorems related to optimisation has the knowledge of methods and algorithms useful to solving optimization problems	**P7U_W**	**P7S_WG**	
K2APR_W2	has knowledge about description methods of phenomena accoutring in physical objects and processes and modelling dynamical objects and processes, especially those with relevance to electrical engineering he has the knowledge in the field of discrete models description and application, specially neuronal models, fuzzy models, models utilising state estimators	**P7U_W**	**P7S_WG**	
K2APR_W3	has an increased knowledge about linear and nonlinear control system stability, formulation and solving optimal control problems, solving linear quadratic control problems	**P7U_W**	**P7S_WG**	
K2APR_W4	knows the general rules of control object models identification, identification methods of static, dynamic, parametric, non-parametric, stationary, non-stationary, feedback objects and time series	**P7U_W**	**P7S_WG**	
K2APR_W5	has knowledge about management, including quality management and business running		**P7S_WK**	**P7S_WK_inż**

	he knows the basics of entrepreneurship based			
K2APR_W6	he understands the legal and standardisation framework of engineering and the need to act accordingly to it in everyday practice has the knowledge about technical standardisation basics, responsibility for the quality and safety of manufactured goods, assessment of compatibility, making patent descriptions and patent database		**P7S_WK**	
SKILLS (U)				
K2APR_U1	is able to formulate an optimisation problem and solve it using available computational tools	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
K2APR_U2	is able to simulate in Matlab, selected phenomena accruing in dynamical systems	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
K2APR_U3	knows how to solve practically an control object model identification task in Matlab	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
K2APR_U4	depending on the choice of level of studied language, student: has knowledge, abilities and competence compatible with requirements specified for additional B2+ ESOKJ level characteristic for scientific and technical language connected with the studied discipline and related fields or has knowledge, abilities and competence compatible with requirements specified for additional C1+ ESOKJ level; makes use of specialist texts on his/her own, uses scientific and technical language in both oral and written forms, analyses given texts and presents them in various specialist debates	**P7U_U**	**P7S_UK** **P7S_UU**	

K2APR_U5	depending on the choice of level of studied language, student: has knowledge, abilities and competence compatible with requirements specified for A1 ESOKJ level, has basic knowledge of studied language, knows daily life and fundamental intercultural behaviour basic vocabulary and grammatical structures or has knowledge, abilities and competence compatible with requirements specified for A2 ESOKJ level, uses vocabulary and grammatical structures related to the studied field and accordingly with the socio-cultural knowledge, can participate in discussions on common subjects and to a certain extent talk about studies and professional work	**P7U_U**	**P7S_UK** **P7S_UU**	
K2APR_U6	is able to formulate and justify opinions, present problems related to studied field, related to working environment, also participate in scientific and professional discussions	**P7U_U**	**P7S_UW** **P7S_UK**	
SOCIAL COMPETENCES (K)				
K2APR_K1	understands the need for live long learning and rising qualifications		**P7S_KK**	
K2APR_K2	is able for a teamwork on a complex engineering task, according to his role in the team and the working time schedule	**P7U_K**		
K2APR_K3	is aware about the importance and non-technical aspects of an control engineer activities, i.e. influence on environment, therefore takes responsible actions		**P7S_KO** **P7S_KR**	
K2APR_K4	correctly identifies and solves dilemmas related to profession	**P7U_K**	**P7S_KK** **P7S_KR**	

K2APR_K5	has the awareness of the social role of an technical university alumnus especially understands the need of formulating and publishing, i.e. via mass media, information and opinions in the control engineering filed in an comprehensive manner	**P7U_K**	**P7S_KO**	
K2APR_K6	he can think critically and support his own view, so he can select priorities properly and choose appropriate measures to achieve the tasks defined by himself or other people taking into account the issues of social responsibility	**P7U_K**	**P7S_KO**	
K2APR_K7	knows the team work rules knows how to lead a small team and how to take responsibilities for the results	**P7U_K**	**P7S_KR**	

*delete as applicable

Attachment no. 1

Specialization Automation of Machines, Vehicles and Apparatus

Specialization learning outcomes	**Description of learning outcomes for the specialization Automation of Machines, Vehicles and Apparatus**	Reference to PRK characteristics		
		Universal first degree characteristics (U)	Second degree characteristics typical for qualifications obtained in higher education (S)	
			Characteristics for qualifications on ~~6 /~~ 7* levels of PRK	Characteristics for qualifications on ~~6 and~~ 7 levels of PRK, enabling acquiring engineering competences
KNOWLEDGE (W)				
S2AMPU_W1	has broadened and deepened knowledge about control theory, advanced methods of control theory applied in electrical drive automation, including adaptive control, predictive control, with a feedback to state control, sensor less control, knows contemporary methods of phasor control in AC drives, phasor modulation, state variables restoration	**P7U_W**	**P7S_WG**	**P7S_WG_inż**
S2AMPU_W2	has a knowledge about construction and characteristics of electrical micro machines used in industrial automation is able to explain their operational and control principles knows the key applications of electrical micromachines	**P7U_W**	**P7S_WG**	**P7S_WG_inż**
S2AMPU_W3	has a deepened, broadened and structured knowledge of intelligent analogue and digital measurement transducers of electrical and non-electrical quantities applied in standardised measurement systems	**P7U_W**	**P7S_WG**	**P7S_WG_inż**

S2AMPU_W4	has the knowledge about signal processors applications in industrial automation is able to program a processor for a specific task knows the methods for signal processing programming is able to formulate the requirements for a program, knows how to program a signal processor	**P7U_W**	**P7S_WG**	**P7S_WG_inż**
S2AMPU_W5	has a deepened knowledge about proper selection and utilising of industrial robots in selected industrial processes (palletisation, mechanical tooling, welding, painting, etc.) also about parameters and instrumentation of typical industrial robots and manipulators	**P7U_W**	**P7S_WG**	**P7S_WG_inż**
S2AMPU_W6	has a broadened and deepened knowledge about practical implementations of artificial intelligence in control, state variables estimation and diagnostics of industrial systems knows different types of neural networks and has advanced knowledge about neural networks optimisation has an advanced knowledge about various fuzzy systems (Mamdani, TSK, Tsukamoto, with parametric conclusions, with second type sets) knows hardware realisations of algorithms based on artificial intelligence (signal processors, FPGA)	**P7U_W**	**P7S_WG**	**P7S_WG_inż**
S2AMPU_W7	has knowledge about measurement systems architecture, test systems architecture, including the hardware layer and programs written in higher level languagesk nows and understands the methodology for planning of measurement and testing systems	**P7U_W**	**P7S_WG**	**P7S_WG_inż**

S2AMPU_W8	has a deepened and broadened knowledge about power electronics and electric drives understands the methodology for the planning of complex systems using computer aided design methods	**P7U_W**	**P7S_WG**	**P7S_WG_inż**
S2AMPU_W9	has knowledge about object oriented programming is able to define a problem, describe it, and propose a realisation method is able to choose a developer tool needed for writing a program	**P7U_W**	**P7S_WG**	**P7S_WG_inż**
S2AMPU_W10	has broadened and deepened knowledge about power electronic applications in industrial appliances, ,including converter drives utilising thyristor and transistor technology knows the development tendencies in that field	**P7U_W**	**P7S_WG**	**P7S_WG_inż**
S2AMPU_W11	has a structured knowledge about wireless data transmission systems utilising GSM/GPRS, IrDA, Bluetooth and WLAN knows how to chose an appropriate wireless technology accordingly to requirements	**P7U_W**	**P7S_WG**	**P7S_WG_inż**
S2AMPU_W12	has an extended knowledge in the converter automation systems	**P7U_W**	**P7S_WG**	**P7S_WG_inż**

S2AMPU_W13	has an extended knowledge in the analysis of disturbances and failures in complex electrical systems	**P7U_W**	**P7S_WG**	**P7S_WG_inż**
SKILLS (U)				
S2AMPU_U1	is able to carry out experimental research on advanced drive control structures, DC and AC, including sensor less control. Is able to elaborate and conclude results	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2AMPU_U2	is able to integrate the knowledge of automation, metrology, electronics, data transmission for the formulation and solution of tasks related to modelling and design of basic virtual measurement systems and devices	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2AMPU_U3	is able to recognise the type of a signal processor and apply it in a electronic system is able to choose the signal processor for a given task is able to program the selected processor is able to analyse and test written program is able to do launching work using proper diagnostic and software tools	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2AMPU_U4	is able to work out simple applications utilizing arm robots, SCARA, mobile or Cartesian	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2AMPU_U5	is able to realise as software various structures of neural networks, and then use them as controllers, estimators, classifiers, detectors, including applications in electrical drives is able to design control systems with different types of fuzzy controllers is able to assess critically the performance of fuzzy systems	**P7U_U**	**P7S_UW**	**P7S_UW_inż**

S2AMPU_U6	has a practice oriented ability to construct computer measurement systems utilising integrated programming environment, standard interfaces and measurement devices is able to construct and program a measurement system, including data acquisition, data processing, and visualisation	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2AMPU_U7	is able to work out a program to simulate complex structures of dynamic systems, including power electronic elements, is able to analyse and interpret obtained results	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2AMPU_U8	is able to apply an adequate programming tool is able to analyse requirements for a program, is able to assess the usability of a given programming environment is able to write a program in a given object oriented language, is able to analyse and grade a written program, launch it and modify it accordingly to requirements	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2AMPU_U9	is able to organize and work out experimental research of industrial power electronic systems, including thyristor and transistor based technologies is able to elaborate and interpret research results	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2AMPU_U10	is able to configure and program a complex microcontroller PLC is able to solve communication problems of new generation controllers	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2AMPU_U11	able to model, design and experimentally investigate Converter automation systems	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2AMPU_U12	able to measure and analyze disturbances and damages of electrical systems	**P7U_U**	**P7S_UW**	**P7S_UW_inż**

S2AMPU_U13	is able to prepare a presentation with the results of his master thesis in polish he is able to justify in a discussion the realisation process and reached results he knows the rules of creative discussion	**P7U_U**	**P7S_UW** **P7S_UK**	**P7S_UW_inż**
S2AMPU_U14	is able to compose master thesis in the scope of specialisation Automation of Machines, Vehicles and Apparatus: - is able to get the information from literature, databases and other sources. He is able to merge information and make critical analysis - is able to plan and make experiments, including measurements and computer simulations, interpret results, conclude - is able to use analytical, experimental and simulation methods for the problems formulation and solution process. - is able to formulate and test hypothesis related to scientific problems. - is able to integrate knowledge from various fields of science and exhibit a system approach including nontechnical aspects. - is able to assess the usability of new achievements in technic and technology in the represented scientific discipline. - is able to propose innovative modifications of existing technical solutions. - is able to interpret obtained results, conclude and formulate recommendations - is able to compose diploma thesis according to formal requirements	**P7U_U**	**P7S_UW** **P7S_UK** **P7S_UO**	**P7S_UW_inż**

*delete as applicable

Attachment no. 2

Specialization Automation and Control in Electrical Power Systems

Specialization learning outcomes	**Description of learning outcomes for the specialization Automation and Control in Electrical Power Systems**	Reference to PRK characteristics		
		Universal first degree characteristics (U)	Second degree characteristics typical for qualifications obtained in higher education (S)	
			Characteristics for qualifications on ~~6 /~~ 7* levels of PRK	Characteristics for qualifications on ~~6 and~~ 7 levels of PRK, enabling acquiring engineering competences
KNOWLEDGE (W)				
S2ASE_W1	has the knowledge about application of automation and control systems in national power grid, including the knowledge necessary for a characterisation of the national grid as a automation and control object, understanding and automation and control function description in normal and abnormal conditions of the power system, understanding and characterising the basic rules for information transfer in automation and control systems, also the structure and function of various levels of control rooms	**P7U_W**	**P7S_WG**	**P7S_WG_inż**
S2ASE_W2	has a detailed knowledge of the optic fibre telecommunication system operation, the phenomena utilised in optical sensors measuring various physical quantities	**P7U_W**	**P7S_WG**	
S2ASE_W3	knows the rules for design and programming of algorithms used for automation problem solution has a structured knowledge about automation basics, enabling understanding and designing process automation dedicated to power generation, transmission and distribution	**P7U_W**	**P7S_WG**	**P7S_WG_inż**

S2ASE_W4	has the knowledge about dynamical correction description and use, the interaction of voltage and current measurement transformers and digital protection, discrete algorithms used to detect and classify faults in power systems	**P7U_W**	**P7S_WG**	**P7S_WG_inż**
S2ASE_W5	knows the problems of a dispatcher supervision of a power system, knows the computer systems used for power system supervision, automation, power flow control and data acquisition	**P7U_W**	**P7S_WG**	**P7S_WG_inż**
S2ASE_W6	has the knowledge about the role of electromagnetic transients in power system for the purpose of automation in electrical power systems	**P7U_W**	**P7S_WG**	**P7S_WG_inż**
S2ASE_W7	has the knowledge about theory and examples of artificial intelligence application to power protection knows expert systems, fuzzy logic systems, fuzzyfication and defuzzyfication methods, neural networks, genetic algorithms, hybrid intelligent systems	**P7U_W**	**P7S_WG**	**P7S_WG_inż**
S2ASE_W8	has the knowledge about software and hardware solutions used in power system protection, especially the discrete filtering, measurement of criteria quantities and decision making	**P7U_W**	**P7S_WG**	**P7S_WG_inż**
S2ASE_W9	has the knowledge about planning and designing low voltage electrical installations in buildings, including low regulations and standards knows the rules of selecting apparatus and installation	**P7U_W**	**P7S_WG**	**P7S_WG_inż**

	elements has the knowledge about power quality in low voltage installations knows the control systems of electrical appliances			
S2ASE_W10	has a structured and theoretically founded knowledge about effective power supply and effective power utilisation in industry and homes knows the methods of energy saving he is able to characterise the technical, economic and legal means for demand shaping he knows the techniques for demand site management (DSM)	**P7U_W**	**P7S_WG** **P7S_WK**	**P7S_WG_inż**
S2ASE_W11	understands the fundamental terms related to intelligent buildings and installations knows the differences between a classical and intelligent power installation has a general knowledge about the organisation of building management systems and analogue and digital intelligent installation systems he has the knowledge about construction and operation of intelligent systems, design and launch of intelligent installations	**P7U_W**	**P7S_WG** **P7S_WK**	**P7S_WG_inż**
S2ASE_W12	has extended knowledge in the field of modern electrical appliances and power systems	**P7U_W**	**P7S_WG**	**P7S_WG_inż**
S2ASE_W13	has an extended knowledge in the application of modern control methods in automation and industrial informatics	**P7U_W**	**P7S_WG**	**P7S_WG_inż**
S2ASE_W14	has extended knowledge in the field of applications of converter systems in power engineering	**P7U_W**	**P7S_WG**	**P7S_WG_inż**
SKILLS (U)				
S2ASE_U1	is able to install, trim and make a research on the operation of basic control systems used in power engineering	**P7U_U**	**P7S_UW**	**P7S_UW_inż**

S2ASE_U2	is able to analyse the electromagnetic field based on the known geometry of a circuit is able to analyse the power system operation and compute its effectiveness in normal operational conditions	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2ASE_U3	is able to manage the coordination problems between measurement transducers and digital protection systems. Is able to model digital detection, classification and fault location algorithms in electrical power systems using ATPDraw and Matlab	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2ASE_U4	is able to model using ATP/EMTP complex elements of the power system: generators, transformers, power lines, loads, etc. is able to model with ATP/EMTP electromagnetic transients in complex systems is able to prepare input data and make a good interpretation of simulation results	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2ASE_U5	is able to implement and test selected artificial intelligence methods (fuzzy logic systems, artificial neural networks, genetic algorithms, etc.) for controland protection in electrical power systems applications	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2ASE_U6	is able to analyse and design discrete measurement and decision making systems used in power system protection	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2ASE_U7	is able to design a low voltage electrical installation in a building, including industrial building, including the selection and dimensioning of installation elements including security devices and is able to design control systems and protection devices	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2ASE_U8	has the ability to analyse the utilisation mode of electrical energy he is able to take actions increasing the effectiveness of energy utilisation	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2ASE_U9	is able to make a design of intelligent installation in a given BMS system	**P7U_U**	**P7S_UW**	**P7S_UW_inż**

	program, run and test the installation, introduce changes in the operation routine.			
S2ASE_U10	is able to formulate an algorithm, write a program in ANSI C, run and test it using a microcontroller is able to design and program himself a simple electronic device using a starting kit	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2ASE_U11	able to design and explore experimentally complex power systems	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2ASE_U12	can apply modern methods of control in automation and industrial informatics	**P7U_U**	**P7S_UW**	**P7S_UW_inż**
S2ASE_U13	is able to prepare a presentation with the results of his master thesis in polish he is able to justify in a discussion the realisation process and reached results he knows the rules of creative discussion	**P7U_U**	**P7S_UW** **P7S_UK**	**P7S_UW_inż**
S2ASE_U14	is able to compose master thesis in the scope of specialisation Automation and Control in Electrical Power Systems: – is able to get the information from literature, databases and other sources. He is able to marge information and make critical analysis – is able to plan and make experiments, including measurements and computer simulations, interpret results, conclude – is able to use analytical, experimental and simulation methods for the problems formulation and solution process – is able to formulate and test hypothesis related to scientific problems	**P7U_U**	**P7S_UW** **P7S_UK** **P7S_UO**	**P7S_UW_inż**

	– is able to integrate knowledge from various fields of science and exhibit a system approach including nontechnical aspects – is able to assess the usability of new achievements in technic and technology in the represented scientific discipline – is able to propose innovative modifications of existing technical solutions – is able to interpret obtained results, conclude and formulate recommendations – is able to compose diploma thesis according to formal requirements			

*delete as applicable