Zał. Nr 2 do ZW 16/2020

ASSUMED LEARNING OUTCOMES

FACULTY: .....Electronics.....

MAIN FIELD OF STUDY: ..... Electronic and computer engineering.....

EDUCATION LEVEL: first-level

PROFILE: general academic

Location of the main-field-of study:

Branch of science: …… Engineering ……..

Discipline

…… Automation, Electronics and Electrotechnics ……

Explanation of the markings:
P6U – universal first degree characteristics corresponding to education at the first-level studies - 6 PRK level *
P7U – universal first degree characteristics corresponding to education at the second-level studies - 7 PRK level *

P6S – second degree characteristics corresponding to education at the first-level studies - 6 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"
K (*faculty symbol*) _W1, K (*faculty symbol*) _W2, K (*faculty symbol*) _W3, … - main-field-of study learning outcomes related to the category "knowledge"
K (*faculty symbol*) _U1, K (*faculty symbol*) _U2, K (*faculty symbol*) _U3, … - main-field-of study learning outcomes related to the category "skills"
K (*faculty symbol*) _K1, K (*faculty symbol*) _K2, K (*faculty symbol*) _K3, … - main-field-of study learning outcomes related to the category "social competences"
S (*faculty symbol*) _W.., S (*faculty symbol*) _W.., S (*faculty symbol*) _W.., … - specialization learning outcomes related to the category "knowledge"
S (*faculty symbol*) _U.., S (*faculty symbol*) _U.., S (*faculty symbol*) _U.., … - specialization learning outcomes related to the category "skills"
S (*faculty symbol*) _K.., S (*faculty symbol*) _K.., S (*faculty symbol*) _K.., … - specialization learning outcomes related to the category "social competences"
… _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** **… Electronic and Computer Engineering ……** After completion of studies, the graduate:	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)				
K1EAC_W01	has basic knowledge of mathematics, including mathematical analysis, algebra, geometry, probability and numerical methods, necessary for the description, analysis and synthesis of automation and robotics systems and basic processes occurring in them	P6U_W	P6S_WG P6S_WK	
K1EAC_W02	has a basic knowledge of classical mechanics, wave motion, mechanics, quantum optics, electric and magnetic fields and is familiar with the basics of metrology, theory and measurement techniques of electrical and non-electrical quantities	P6U_W	P6S_WG	P6S_WG
K1EAC_W03	knows the basics of information technology and the engineering and methodology of object-oriented programming, together with the basic tools and programming environments	P6U_W	P6S_WG	
K1EAC_W04	has knowledge of the basic principles of constructing electronic devices and the basics of operation and application of electronic components and sensors; has basic knowledge of methods and programmes for analysing electronic circuits	P6U_W	P6S_WG	P6S_WG
K1EAC_W05	has a basic knowledge of terminology, basic tasks, techniques and components of automation and robotics	P6U_W	P6S_WG	P6S_WG

K1EAC_W06	knows the basics of telecommunications and defines basic concepts of wireline, wireless and optical telecommunications	P6U_W	P6S_WG	
K1EAC_W07	is familiar with the basic issues of digital deterministic signal processing theory and microprocessor and microcontroller programming	P6U_W	P6S_WG	
K1EAC_W08	has the knowledge to understand non-technical conditions of engineering activities; he knows the principles of creating individual entrepreneurship	P6U_W	P6S_WG	
K1EAC_W09	knows the basics of systems theory, properties of basic systems structures and how to solve simple identification, recognition and control tasks	P6U_W	P6S_WG	
K1EAC_W10	knows the basics of computer network technology, computer network protocols, design and configuration of computer networks	P6U_W	P6S_WG	
K1EAC_W11	knows the fundamental principles of optoelectronics in terms of generation, detection and processing of optical radiation	P6U_W	P6S_WG P6S_WK	
K1EAC_W12	knows the basic concepts of mechanical vibrations and acoustic waves and systems, and characterises the properties of electroacoustic transducers, devices and systems.	P6U_W	P6S_WG	P6S_WG
SKILLS (U)				
K1EAC_U01	solves and documents independently an engineering task using literature, materials and equipment, applies matrix calculus, vector calculus and differential and integral calculus, applies fast Fourier transform, performs operations on complex numbers	P6U_U	P6S_UW P6S_UU	P6S_UW
K1EAC_U02	can correctly and effectively apply the known principles and laws of physics to the qualitative and quantitative analysis of physical engineering problems	P6U_U	P6S_UW	P6S_UW
K1EAC_U03	knows how to use information techniques, to create object-oriented, multithreaded, graphic and mobile programs	P6U_U	P6S_UW	P6S_UW

K1EAC_U04	is able, according to given specifications and using adequate methods, techniques and tools (e.g. computer simulation), to design and manufacture simple electrical or electronic equipment	P6U_U	P6S_UW	P6S_UW
K1EAC_U05	is able to simulate and analyse basic automation and robotics objects using appropriate tools.	P6U_U	P6S_UW P6S_UK	P6S_UW
K1EAC_U06	is able to present the structure of modern telecommunication networks and configure the basic functionalities of selected systems	P6U_U	P6S_UW P6S_UK	P6S_UW
K1EAC_U07	is able to prepare and run software using the internal structure of microcontrollers	P6U_U	P6S_UW P6S_UU P6S_UO	
K1EAC_U08	is able to solve a given engineering task using his/her acquired knowledge and skills, and is able to acquire information from other sources in the process of self-study; while solving he/she also takes into account non-technical aspects; is able to create documentation of the solution and to present it in a clear and legible manner	P6U_U	P6S_UW	P6S_UW
K1EAC_U09	has the ability to represent expert and experimental knowledge in the form of block diagrams, graphs, sets of logical expressions, in particular the creation of input-output systems and their mathematical models	P6U_U	P6S_UW	P6S_UW
K1EAC_U10	Is able to distinguish between network devices and network services, be able to design IP addressing, be able to construct a simple computer network	P6U_U	P6S_UW P6S_UK	P6S_UW
K1EAC_U11	is able to carry out experiments in the field of laser and fibre optics technology. Can independently interpret the results obtained	P6U_U	P6S_UW P6S_UK	
K1EAC_U12	know how to carry out basic acoustic measurements and how to analyse and interpret the results of measurements.	P6U_U	P6S_UW P6S_UK	
K1EAC_U13	is able to use a variety of foreign language sources of information, in particular professional literature, and to integrate information obtained			

SOCIAL COMPETENCES (K)				
K1EAC_K01	is aware of the importance and understanding of the humanistic aspects and implications of engineering activities. learns about the effects of engineering activities on the environment, and the related social responsibility of science and technology.	P6U_K	P6S_KK	
K1EAC_K02	correctly identifies and solves dilemmas related to the profession; is aware of the social role of a graduate of a technical university. understands the need to formulate and convey to the society the information and opinions on the achievements of technology and other aspects of engineer's activity; he/she is able to convey such information and opinions in an understandable way, justifying different points of view.	P6U_K	P6S_KK, P6S_KR	
K1EAC_K03	understands the legal aspects and implications of engineering activities	P6U_K	P6S_KO	
K1EAC_K04	is able to work with a team on a complex engineering task taking various roles in the team, is able to perform the assigned tasks in accordance with the work schedule.	P6U_K	P6S_KO	
K1EAC_K05	is aware of the necessity of individual and team activities beyond engineering	P6U_K	P6S_KO	

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Attachment no. 2. to the Program of Studies

DESCRIPTION OF THE PROGRAM OF STUDIES

Main field of study … Electronic and computer engineering **Profile ……** general academic **…...**

Level of studies ……first**……** **Form of studies …**stationary**…**

1. General description

1.1 Number of semesters: 7	*1.2 Total number of ECTS points necessary to complete studies at a given level: 210*
1.3 Total number of hours: 2565	*1.4 Prerequisites (particularly for second-level studies):* *The competition of grades from maturity certificate and certificate of secondary school.* *In case of foreign students, secondary school certificate, received after the completion of a recognized secondary school (total 12 years of education), being the equivalent of Polish maturity certificate accepted by Kuratorium Oświaty.* *Detailed requirements are stated by the Senate of Wroclaw University of Technology and the Faculty of Electronics Council every year*

1.5 Upon completion of studies graduate obtains professional degree of: …Engineer……	*1.6 Graduate profile, employability:* *Undergraduate studies are not divided into specializations. They enable to get primary and organized knowledge in the field of electronics, automation and robotics, and computer science. After graduation, the graduate will be able to:* • *To design, implement, test and operate analog, digital and mixed signal electronic circuits with the use of electronic components and optoelectronic integrated circuits and microprocessors, plan and design circuits and systems, optimize measurement conditions and to analyze and interpret the test results.* • *Use personal computing for the acquisition of measurement results, technological process control, design, commissioning, maintenance of automation and industrial robotics exchange of information based on standard data protocols.* *To solve computing tasks using computer tools, prepare, execute, and analyze computer simulations and experiments, make by yourself computer programs, including programs for implementation of DSP algorithms.*
1.7 Possibility of continuing studies:	*1.8 Indicate connection with University's mission and its development strategy:*

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
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- Second-cycle studies in the fields of Electronics, Automation and Robotics, Computer Science, Telecommunications and related fields.	*The program is consistent with the Electronic Faculty Development Plan established by the Faculty Council on 22nd February 2012.* *The Faculty Development Plan is fully correlated with the university's mission and its development strategy adopted by the Senate of Wrocław University of Technology in 2011. The relations are apparent for example in par. 3 of the Development Plan "Faculty Mission and Perspectives" and in par. 4 "Sector Models", where the Educational Model and Study Model are described, together with the Model for External Cooperation that considers job opportunities and forming of the network of influence*

2. Detailed description

2.1 Total number of learning outcomes in the program of study: W (knowledge) =. 12.., U (skills) = 13., K (competences) = .5....., W + U + K = ...30....

2.2 For the main field of study assigned to more than one discipline - the number of learning outcomes assigned to the discipline:

nd

2.3 For the main field of study assigned to more than one discipline - percentage share of the number of ECTS points for each discipline:

nd

2.4a. For the general academic profile of the main field of study – the number of ECTS points assigned to the classes related to the University's academic activity in the discipline or disciplines to which the main field of study is assigned – DN (must be greater than 50% of the total number of ECTS points from 1.2) .. 205 ECTS..

2.4b. For the practical profile of the main field of study - the number of ECTS points assigned to the classes shaping practical skills (must be greater than 50% of the total number of ECTS points from 1.2)

2.5 Concise analysis of compliance of the assumed learning outcomes with the needs of the labor market

The work market for engineering graduates majoring in Electronic and Computer Engineering (ECE) covers the whole country, region of Lower Silesia and Wroclaw. The program of study covers all the basic needs and requirements of the work market for electronics and computer engineers. Profile of the companies that will benefit from the competence of graduates is mainly manufacturing and service

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companies. In this area, there is and will be a significant demand for professionals with the title of electronics engineer, possessing the skills of integration of the electronic equipment and analogue and digital systems (including microprocessor) in broadly covered industrial automation. These skills include, among others, PLC programming, PAC, SCADA systems and robotic systems, conduct commissioning of control systems, local and remote maintenance, supervision over operating control systems of production. Also the ability to design broadly defined control systems, telemetry systems and the measurement will be on the work market received very positively. Currently there is a significant increase in the number of companies specializing in buildings and homes automation. These objects require care and conservation engineers. In the Lower Silesia region operates a significant number of small and medium-sized enterprises and factories, where engineering skills are and will find appreciation in the period of many years to come.

An additional advantage of graduates will be the practical knowledge of English, which will expand its opportunities in the growing number of foreign companies with their research and development and / or production facilities in the Lower Silesia and the whole Poland.

2.6. The total number of ECTS points that a student must obtain in classes requiring direct participation of academic teachers or other persons conducting classes and students (enter the sum of ECTS points for courses / groups of courses marked with the BU[1] code) . 109,5. ECTS

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2.7. Total number of ECTS points, which student has to obtain from basic sciences classes

Number of ECTS points for obligatory subjects	25
Number of ECTS points for optional subjects	
Total number of ECTS points	25

2.8. Total number of ECTS points, which student has to obtain from practical classes, including project and laboratory classes (enter total number of ECTS points for courses/group of courses denoted with code P)

Number of ECTS points for obligatory subjects	71
Number of ECTS points for optional subjects	59
Total number of ECTS points	130

2.9. Minimum number of ECTS points, which student has to obtain doing education blocks offered as part of University-wide classes or other main field of study (enter number of ECTS points for courses/groups of courses denoted with code O)

…35. ECTS points

2.10. Total number of ECTS points, which student may obtain doing optional blocks (min. 30% of total number of ECTS points)

…83. ECTS points

3. Description of the process leading to learning outcomes acquisition:

While following the curriculum, students attend organised classes. In accordance with the rules of higher education at Wrocław University of Technology, students are obliged to participate in classes. Classes are conducted in the forms specified in the study regulations, using both traditional methods and The e-learning platform is used as well as traditional methods and didactic tools. Outside class time, instructors are

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available for students in the following times Outside of class hours, instructors are available for students during designated and announced on the Faculty website consultation hours.

An important element of learning is the student's own work, which consists in preparing preparation for classes (on the basis of materials provided by Tutors, as well as the recommended literature), literature studies, preparation of reports and reports, preparing for colloquia and examinations. Each PRK learning outcome is assigned a course code present in the study programme. The passing of these courses (this course) means obtaining the given effect. The courses are passed on the basis of the forms of control of the acquired knowledge, skills and social competences defined in the course charter. Failure of a student to achieve

The student's failure to achieve the learning outcomes assigned to the course will result in failing the course and having to repeat it.

As part of the study programme, students complete student work placement of no less than 160 hours. In-service training is carried out in a company. The basis for the student to receive credit for the internship is a confirmation of the internship. The basis for the completion of the in-service training is the confirmation of its completion and a positive assessment by the employer.

The passing of the in-service training is a confirmation of the realization of the learning outcomes ascribed to it. The completion of each semester of studies is conditional on obtaining the number of ECTS credits specified in the study programme. The completion of each semester of studies is conditional on obtaining the number of ECTS credits specified in the study programme, which is equivalent to achieving the majority of The completion of each semester of study is conditional on the number of ECTS credits specified in the study programme. Courses not passed must be repeated in subsequent semesters, thus achieving the remaining learning outcomes. learning outcomes.

Successful completion of the studies is possible after the student has achieved all the learning outcomes specified in the study programme. The quality of the classes conducted and the achievement of learning outcomes are controlled by the Departmental Educational Quality Assurance System, which includes, among other things, procedures for developing and modifying curricula, individualising study programmes, conducting the teaching process and graduation.

Quality control of the education process includes evaluation of the learning outcomes achieved by the students. Quality control of conducted classes is supported by hospitalizations and surveys, conducted according to strictly defined departmental procedures.

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[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
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4. List of education blocks:

4.1. List of obligatory blocks:

4.1.1 List of general education blocks

4.1.1.1 *Liberal-managerial subjects* block *(min. ..... ECTS points):*

4.1.1.2 *Foreign languages* block *(min. ..... ECTS points):*

4.1.1.3 *Sporting classes* block *(0 ECTS points):*

4.1.1.4 *Information technologies* block *(min. .... ECTS points):*

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	ECEA00002	Introduction to Programming **GK**	2		3			K1EAC _W03 K1EAC _U03	75	240	8	8	6	T	Z(lec)			4	KO
		Total	**2**	**0**	**3**	**0**	**0**	-	**75**	**240**	**8**	**8**	**6**	-	-	-	-	**4**	-

Altogether for general education blocks

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					
2	**0**	**3**	**0**	**0**	**75**	**240**	**8**	**8**	**6**

4.1.2 List of basic sciences blocks

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

4.1.2.1 *Mathematics* block

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	MAT001509	Math - Analysis 1 **GK**	2	2				K1EAC _W01 K1EAC _U01	60	240	8	8	2	T	E(lec)	O		3	PD
2	MAT001511	Math - Analysis 2 **GK**	2	2				K1EAC _W01 K1EAC _U01	60	150	5	5	2	T	E(lec)	O		2	PD
3	MAT001510	Math - Algebra **GK**	2	2				K1EAC_W01 K1EAC _U01	60	240	8	8	2	T	E(lec)	O		3	PD
		Total	**6**	**6**	**0**	**0**	**0**	-	**180**	**630**	**21**	**21**	**6**	-	-	-	-	**8**	-

4.1.2.2 *Physics* block

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	FZP001127	Physics **GK**	2		2			K1EAC _W02 K1EAC _U02	60	180	6	6	2	T	E(lec)	O		3	PD
		Total	**2**	**0**	**2**	**0**	**0**	**-**	**60**	**180**	**6**	**6**	**2**	-	-	-	-	**3**	-

4.1.2.3 *Chemistry* block

Altogether for basic sciences blocks:

Total number of hours	Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
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[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
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lec	cl	lab	pr	sem					
8	**6**	**2**	**0**	**0**	**240**	**810**	**27**	**27**	**8**

4.1.3 List of the main field of study blocks

4.1.3.1 *Obligatory main field of study* blocks

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	MAT001512	Math for Electronics **GK**	2	2				K1EAC _W01 K1EAC _U01	60	120	4	4	2	T	Z(lec)			2	PD
2	ECEA00014	Physics for Electronics **GK**	2	2				K1EAC _W02 K1EAC _U02	60	180	6	6	2	T	Z(lec)			3	PD
3	ECEA17004	Object oriented programming **GK**	2		2			K1EAC _W03 K1EAC_U03	60	150	5	5	3	T	E(lec)			3	PD
4	ECEA00007	Scientific_and_Engineering_Programming **GK**	2		2			K1EAC _W03 K1EAC _U03	60	150	5	5	2	T	Z(lec)			3	K
5	ECEA00010	Programming Systems & Environments **GK**	2		2			K1EAC _W03 K1EAC _U03	60	120	4	4	2	T	Z(lec)			2	K
6	ECEA00001	Metrology **GK**	1	1	2			K1EAC _W02 K1EAC _U02	60	120	4	4	2	T	Z(lec)			3	K
7	ECEA00003	Electronics **GK**	3	3	2			K1EAC _W04 K1EAC _U04	120	240	8	8	4	T	Z(lec)			5	K
8	ECEA00016	Electronic_Components_and_Sensors **GK**	3	1	2			K1EAC _W04 K1EAC_U04	90	240	8	8	3	T	E(lec)			5	K
9	ECEA00006	Electronic_Technology **GK**	2		2			K1EAC _W04 K1EAC _U04	60	150	5	5	3	T	Z(lec)			3	K
10	ECEA00009	Electronic_circuits **GK**	2		2	2		K1EAC _W04 K1EAC _U04	90	240	8	8	4	T	E(lec)			5	K
11	ECEA00022	Introduction_to_Microcontrollers **GK**	3		2	1		K1EAC _W07 K1EAC _U07	90	240	8	8	5	T	E(lec)			4	K
12	ECEA00101	Computer_Networks **GK**	2		2			K1EAC _W11	60	120	4	4	2	T	Z(lec)			2	K

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

								K1EAC _U11											
13	ECEA00025	Python **GK**	1	1				K1EAC _W03 K1EAC_U03	30	90	3	3	2	T	Z(lec)			2	K
14	ECEA00019	Introduction to Automation **GK**	2		1			K1EAC _W05 K1EAC_U05	45	90	3	3	2	T	Z(lec)			2	K
15	ECEA00020	Introduction to Robotics **GK**	2		1			K1EAC _W05 K1EAC_U05	45	90	3	3	2	T	Z(lec)			2	K
16	ECEA19202	Microcontrollers **GK**	2		2	1		K1EAC _W07 K1EAC _U07	75	150	5	5	4	T	E(lec)			3	K
17	ECEA00021	Fundamentals_of_Telecommunication **GK**	2		2			K1EAC _W06 K1EAC _U06	60	120	4	4	2	T	Z(lec)			2	K
18	ECEA00103	Electroacoustics **GK**	2		2			K1EAC _W12 K1EAC _U12	60	120	4	4	2	T	Z(lec)			2	K
		Total	**37**	**10**	**28**	**4**		-	**1185**	**2730**	**91**	**91**	**48**	**-**	**-**	**-**	**-**	**53**	**-**

Altogether (for main field of study blocks):

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					
37	**10**	**28**	**4**		**1185**	**2730**	**91**	**91**	**48**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

4.2 List of optional blocks

4.2.1 List of general education blocks

4.2.1.1 Liberal-managerial subjects blocks *(min. ..... ECTS points):*

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	FLEA00100	Philosophy	2					K1EAC_K01	30	60	2	2	1	T	Z	O		0	KO
2	PRZ000339	Copyright	2					K1EAC_K02	30	60	2	2	1	T	Z	O		0	KO
3	ZMZ001048	Entrepreneurship	2					K1EAC_K03	30	30	1	1	1	T	Z	O		0	KO
		Total	**6**	**0**	**0**	**0**	**0**	-	**90**	**150**	**5**	**5**	**3**	-	-	-	-	**0**	-

4.2.1.2 ***Foreign languages*** **block** *(min. ..... ECTS points):*

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	From the university pool	Foreign language - A1/A2/B1/B1.2/C1.1		4				K1EAC_U13	60	60	2		1,5	T	Z	O		2	KO
2	From the university pool	Foreign language – B2.1/C1.2		4				K1EAC_U14	60	90	3		2,5	T	Z	O		3	KO
		Total	**0**	**8**	**0**	**0**	**0**	-	**120**	**150**	**5**		**4**	-	-	-	-	**5**	-

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

4.2.1.3 Sporting classes block *(0. ECTS points):*

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	From the university pool	Sport		4				K1EAC_K05	60		0		0	T	Z	O		0	KO
		Total	**0**	**4**	**0**	**0**	**0**	-	**60**	**0**	**0**		**0**	-	-	-	-	**0**	-

4.2.1.4 ***Information technologies*** **block** *(min. .... ECTS points): only the obligatory course*

Altogether for general education blocks:

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					
6	**4**	**8**	**0**	**0**	**270**	**300**	**10**	**5**	**7**

4.2.2 List of basic sciences blocks

4.2.2.1 ***Mathematics*** **block** *(min. .... ECTS points): only the obligatory courses*

4.2.2.2 ***Physics*** **block** *(min. .... ECTS points): only the obligatory courses*

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

4.2.2.3 *Chemistry* block *(min. .... ECTS points): none*

4.2.3 List of blocks

4.2.3.1 Block 1 (SEMESTER 5 – 3 out of 5) *(min. ..21 ECTS points):*

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	ECEA00201	Advanced Topics in Robotics **GK**	2			2	1	K1EAC _W05 K1EAC _U05	75	210	7	7	4	T	Z(lec)			4	K
2	ECEA00102	Digital Signal Processing **GK**	2		3			K1EAC _W07 K1EAC _U07	75	210	7	7	4	T	Z(lec)			4	K
3	ECEA00203	Artificial Intelligence and Computer Vision **GK**	2		2	1		K1EAC _W03 K1EAC _U03	75	210	7	7	4	T	Z(lec)			4	K
4	ECEA00204	Optoelectronics **GK**	2			2	1	K1EAC _W12 K1EAC _U12	75	210	7	7	4	T	Z(lec)			4	K
5	ECEA00205	Wireless systems **GK**	3		2			K1EAC _W06 K1EAC _U06	75	210	7	7	4	T	Z(lec)			4	K
		Total (3 out of 5)	**11**	**0**	**7**	**5**	**2**	**-**	**225**	**630**	**21**	**21**	**12**	**-**	**-**	**-**	**-**	**12**	**-**

4.2.3.2 Block 2 (SEMESTER 6 – 3 out of 5) *(min. ..21 ECTS points):*

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	ECEA00206	Control Systems Engineering **GK**	2		3			K1EAC _W05 K1EAC _U05	75	210	7	7	4	T	E(lec)			4	K

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

2	ECEA00207	Embedded Systems **GK**	2		2	1		K1EAC _W07 K1EAC _U07	75	210	7	7	4	T	E(lec)			4	K
3	ECEA00208	Real Time Operating Systems **GK**	2			3		K1EAC _W03 K1EAC _U03	75	210	7	7	4	T	E(lec)			4	K
4	ECEA00209	Lasers, Fibers and Applications **GK**	2		2		1	K1EAC _W12 K1EAC _U12	75	210	7	7	4	T	E(lec)			4	K
5	ECEA00210	Communication systems and networks **GK**	2		2		1	K1EAC _W06 K1EAC _U06	75	210	7	7	4	T	E(lec)			4	K
		Total (3 out of 5)	**10**	**0**	**9**	**4**	**2**	**-**	**225**	**630**	**21**	**21**	**12**	**-**	**-**	**-**	**-**	**12**	**-**

4.2.3.3 Block 3 (SEMESTER 7 – choice of 2) *(min. ..6 ECTS points):*

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	ECEA00211	Electrotechnics **GK**	2		1			K1EAC _W04 K1EAC _U04	45	90	3	3	1,5	T	Z(lec)			1	K
2	ECEA00212	Medical Electronics **GK**	2				1	K1EAC _W04 K1EAC _U04	45	90	3	3	1,5	T	Z(lec)			1	K
3	ECEA00214	Electronics for Renewable Energy Sources **GK**	2				1	K1EAC _W02 K1EAC _U02	45	90	3	3	1,5	T	Z(lec)			1	K
4	ECEA00216	Virtualization and Cloud Computing **GK**	1		2			K1EAC _W03 K1EAC _U03	45	90	3	3	1,5	T	Z(lec)			1	K
5	ECEA00217	Machine learning **GK**	1			2		K1EAC _W03 K1EAC _U03	45	90	3	3	1,5	T	Z(lec)			1	K
6	ECEA00218	Selected topics in Artificial Intelligence **GK**	2		1			K1EAC _W03 K1EAC _U03	45	90	3	3	1,5	T	Z(lec)			1	K
7	ECEA00220	Ultrasonic technology **GK**	1		2			K1EAC _W02 K1EAC _U02	45	90	3	3	1,5	T	Z(lec)			1	K
8	ECEA00221	Speech communication **GK**	1		2			K1EAC _W02 K1EAC _U02	45	90	3	3	1,5	T	Z(lec)			1	K

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

9	ECEA00223	Introduction to Radar Technology **GK**	2				1	K1EAC _W02 K1EAC _U02	45	90	3	3	1,5	T	Z(lec)			1	K
		Total (choice of 2)	**14**	**0**	**8**	**2**	**3**	**-**	**90**	**180**	**6**	**6**	**3**	**-**	**-**	**-**	**-**	**2**	**-**

4.2.3.4 Other courses *(min. ..26 ECTS points):*

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	ECEA00106	Team & preengineering project			3			K1EAC_K04	75	150	5	5	2,5	T	Z			5	K
2	ECEA17105	Diploma seminar					2	K1EAC _U08	30	60	2	2	1	T	Z			3	K
3	ECEA17100	Final project			12			K1EAC _U08		360	12	12	3	T	E			12	K
4	ECEA16001Q	Intership						K1EAC_U08		180	6	6	6	T	Z			6	K
		Total	**0**	**0**	**15**	**0**	**2**	**-**	**105**	**750**	**25**	**25**	**12,5**	**-**	**-**	**-**		**26**	**-**

Altogether for blocks:

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					
					645	**2190**	**73**	**73**	**39,5**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

4.2.4 List of specialization blocks

4.2.4.1 ***Specialization subjects (e.g. whole specialization)*** **blocks** *(min. .... ECTS points):*

4.2.4.2 ……*(e.g. diploma profile)* block *(min. .... ECTS points):*

Altogether for specialization blocks:

4.3 Training block - concerning principles of training crediting – attachment no. …

Opinion of the Advisory Faculty Council concerning the rules of crediting training block

Name of training		professional	
Number of ECTS points	**Number of ECTS points for BU[1] classes**	**Training crediting mode**	**Code**
6	6	Mark	**ECEP16001Q**

Training duration	**Training objective**
4 weeks (160 hours)	Acquiring effect K1_EAC_U04

4.4 „Diploma dissertation" block (*if it is foreseen at first level studies)*

Type of diploma dissertation	inżynier	
Number of diploma dissertation semesters	**Number of ECTS points**	**Code**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

1	12	**ECEA17100**
Character of diploma dissertation		
Literature survey, project, computer program, etc.		
Number of BU[1] ECTS points	3	
Number of DN ECTS points	12	

5. Ways of verifying assumed learning outcomes

Type of classes	Ways of verifying assumed learning outcomes
lecture	e.g. examination, progress/final test
class	e.g. progress/final test
laboratory	e.g. pretest, report from laboratory
project	e.g. project defence
seminar	e.g. participation in discussion, topic presentation, essay
training	e.g. report from training
diploma dissertation	prepared diploma dissertation

6. Range of diploma examination

1) Systematics and characteristics of direct methods of measurement and of methods for assessing measurement accuracy
2) Basic theorems in electronic circuits: Thevenin, Norton, superposition and power matching theorems. Application of Laplace transform in circuit analysis.
3) Principles of object-oriented design and their imp act on software quality. Compare the structural and object-oriented approaches of software development.
4) Bipolar and unipolar transistors -structure, properties and applications. Fundamentals of analog signal conditioning.
5) Printed circuit boards – substrates, layers, rules. Elements of cooling system of electronic devices
6) What is an operational amplifier? Discuss its characteristic parameters. Give examples of applications. Construction and operation of PLL loops. Give examples of applications.
7) Problems of concurrent thread/process synchronization: synchronization criteria, available mechanisms, an example of the synchronization problem. Elements of object orienting programming in Java.

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

8) Basic telecommunication system: block diagram, coder/decoder, modulation/demodulation, Signal-to-Noise ratio
9) Describe techniques for optimization of logic equations. Microcontroller – describe main elements and how it works
10) Basic tasks of robotics: definition, solution techniques. Principles of modeling and models of wheeled mobile robots.
11) Enumerate and describe components of typical control loop. Describe operating principle and taxonomy of automatic controllers
12) Describe the ISO/OSI reference model and explain the principles of layered approach. Explain the differences between IPv4 and IPv6.
13) Acoustic waves - types, properties, equation. Electroacoustical chain. Distortions and disturbances
14) The physical basis of light amplification in lasers. Thermal and photonic detectors of light.
15) Describe main functionalities of a standard microcontroller's timer. How ADC works? What is meant by sampling, quantizing and encoding?
16) Describe functional model of ARM microcontrollers. How the ARM microcontrollers stand again main families of 8-bit microcontrollers. Programming, debugging, tracing – explain what is meant by those terms and how are they realized in contemporary microcontrollers.

17) *Discrete linear systems - the importance, a mathematical model, time and frequency properties of the model. Quadrature sampling scheme - Hilbert transform, analytical signal, quadrature sampling applications
18) *Methods of task and motion planning for stationary and mobile robots. Methods of localization and environment mapping for mobile robots
19) *Probabilistic knowledge representation and decision making methods. Low-level image processing algorithms - examples, applications
20) *Building management systems (BMS): architecture, equipment, communication protocols, Redundancy, High Availlibility and Safety Related aspects in Distributed Control Systems
21) *The review of lasing media. Describe one of chosen type of laser, its basic parameters and give an example of its application
22) *Wireless and radio systems: classification, applications, used frequency bands, network architectures and functions of individual
23) *HDL Hardware Description Languages: Verilog and VHDL. Components of the language. The structure of the code
24) * Discuss the most important differences between the RTOS (Real-time Operating Systems) and the GPOS (General-purpose Operating Systems); consider the API, scheduler, services, and drivers.

*) During diploma dissertation 4 out of 8 questions shall be chosen depending on the realized set of Optional Courses 1 and 2.

7. Requirements concerning deadlines for crediting courses/groups of courses for all courses in particular blocks

No.	*Course / group of courses code*	*Name of course / group of courses*	*Crediting by deadline of... (number of semester)*

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

1		*All courses/groups of courses from the plan of studies for semester 1 and semester 2*	*5*
2	*ECEP16001Q*	*Intership*	*6*

8. Plan of studies (attachment no. ……)

Approved by faculty student government legislative body:

....
Date name and surname, signature of student representative

....
Date Dean’s signature

*delete as appropriate

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Zał. nr 4 do ZW 16/2020
Attachment no. … to Program of Studies

PLAN OF STUDIES

FACULTY:..... Electronics.....

MAIN FIELD OF STUDY: .... Electronic and Computer Engineering.....

EDUCATION LEVEL: first-level

FORM OF STUDIES: full-time studies

PROFILE: general academic

SPECIALIZATION:.....None.....

LANGUAGE OF STUDY: ……English……..

In effect since ……2021/2022**.....**

*delete as applicable

Plan of studies structure (optionally)

1) in ECTS point layout

(space for scheme of plan)

h\sem.	I	II	III	IV	V	VI	VII
30	Metrology 4	Electronics 8	Electronic components and sensors 8	Electronic circuits 8			Final project 12
29							
28							
27							
26	Introduction to Programming 8						
25							
24					Optional course 1	Optonal course 2	
23				Programming Systems and Environments 4			
22		Object oriented programming 5	Electronic Technology 5				
21					21	21	
20							
19				Fundamentals of Telecommunication 4			
18	Math - Algebra 8						Intership 6
17		Physics 6	Scienific and engineering programming 5				
16							
15				Introduction to Microcontrollers 8			
14							
13							
12			Python 3				Diploma Seminar 3
11		Math - Analysis 5					
10	Math - Analysis 1 8						
9			Physics for electronics 6		Computer Networks 4	Electroacoustics 4	Optional course 3 6
8							
7				Introduction to Automation 3			
6		Math of Electronics 4					
5					Microcontrollers 5	Teem and preengineering project 5	
4							
3			Foreign language 3	Introduction to Robotics 3			Copyright 2
2	Philosophy 2	Foreign language 2					
1							Entrepreneurship 1

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes

[2]Traditional – enter T, remote – enter Z

[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)

[4]University-wide course /group of courses – enter O

[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned

[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses

[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

2) in hourly layout

(space for scheme of plan)

h\sem.	I	II	III	IV	V	VI	VII
28							
27							
26			Electronic components and sensors 31200 **E** **ECEA00016**				
25		Electronics 33200 **ECEA00003**		Electronic circuits 20220 **E** **ECEA00009**			
24							Final project 12h **ECEA17100** Intership **ECEP16001Q**
23							
22			Electronic Technology 20200 **ECEA00006**				
21							
20		Object oriented programming 20200 **E** **ECEA17004**		Programming Systems and Environments 20200 **ECEA00010**	Optonal course 1 15h **ECEA19001BK**	Optional course 2 15h **ECEA00002BK**	
19	Metrology 11200 **ECEA00001**		Scienific and engineering programming 20200 **ECEA00007**				
18							
17							
16		Math - Analysis 22000 **E** **MAT001510**	Python 10100	Fundamentals of Telecommunication 20200 **ECEA00021**			
15	Introduction to Programming 20300 **ECEA00002**						Diploma Seminar 00002 **ECEA17105**
14							
13							
12		Math for Electronics 22000 **MAT001512**	Physics for electronics 22000 **ECEA00014**	Introduction to Microcontrollers 21300 **E** **ECEA00022**			
11							
10							
9	Math - Algebra 22000 **E** **MAT001654**				Computer Networks 20200 **ECEA00101**		Optional course 3 6h **ECEA00003BK**
8		Physics 20200 **E** **FZP001127**	Foreign language 00400 **JZL100928**			Electroacoustics 20200 **ECEA00103**	
7							
6				Introduction to Automation 20100 **ECEA00019**			
5	Math - Analysis 22000 **E** **MAT001653**		Sport 2h **WFW03000**		Microcontrollers 20210 **E** **ECEA19202**		Copyright 20000 **PRZ000339**
4		Foreign language 00400 **JZL100927**		Introduction to Robotics 20100 **ECEA00020**		Team and preengineering project 00030 **ECEA00106**	
3							
2	Philosophy 20000 **FLEA100**		Sport 2h **WFW03000**				Entrepreneurship 20000 **ZMZ001048**
1							

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes

[2]Traditional – enter T, remote – enter Z

[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)

[4]University-wide course /group of courses – enter O

[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned

[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses

[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

1. Set of obligatory and optional courses and groups of courses in semestral arrangement

Semester 1

Obligatory courses / groups of courses Number of ECTS points …28..

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	ECEA00002	Introduction to Programming GK	2		3			K1EAC _W03 K1EAC _U03	75	240	8	8	6	T	Z(lec)			4	KO
2	MAT001653	Math - Analysis 1 **GK**	2	2				K1EAC _W01 K1EAC _U01	60	240	8	8	2	T	E(lec)	O		3	KP
3	MAT001654	Math - Algebra **GK**	2	2				K1EAC_W01 K1EAC _U01	60	240	8	8	2	T	E(lec)	O		3	KP
4	ECEA00001	Metrology GK	1	1	2			K1EAC _W02 K1EAC _U02	60	120	4	4	2	T	Z(lec)			3	KP
		Total	**7**	**7**	**5**	**5**	**0**	**0**	**255**	**840**	**28**	**28**	**12**	-	-	-	-	**13**	

Optional courses / groups of courses (minimum …30.. hours in semester, …2…. ECTS points)

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	FLEA00100	Philosophy	2					K1EAC_K01	30	60	2	2	1	T	Z	O		0	KO
		Total	**2**	**0**	**0**	**0**	**0**	-	**30**	**60**	**2**	**0**	**1**	-	-	-		**0**	-

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Altogether in semester

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					
9	**5**	**5**	**0**	**0**	**285**	**900**	**30**	**30**	**13**

Semester 2

Obligatory courses / groups of courses **Number of ECTS points …28…..**

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	MAT001510	Math - Analysis 2 **GK**	2	2				K1EAC _W01 K1EAC _U01	60	150	5	5	2	T	E(lec)	O		2	KP
2	FZP001127	Physics **GK**	2		2			K1EAC _W02 K1EAC _U02	60	180	6	6	2	T	E(lec)	O		3	KP
3	MAT001512	Math for Electronics **GK**	2	2				K1EAC _W01 K1EAC _U01	60	120	4	4	2	T	Z(lec)			2	KP
4	ECEA17004	Object oriented programming GK	2		2			K1EAC _W03 K1EAC_U03	60	150	5	5	3	T	E(lec)			3	KP
5	ECEA00003	Electronics GK	3	3	2			K1EAC _W04 K1EAC _U04	120	240	8	8	4	T	Z(lec)			5	K
		Total	**11**	**7**	**6**	**0**	**0**	**-**	**360**	**840**	**28**	**28**	**13**	**-**	**-**	**-**		**15**	**-**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Optional courses / groups of courses (minimum …4… hours in semester, …2…. ECTS points)

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	From the university pool	Foreign language- A1/A2/B1/B2.1/C1.1		4				K1EAC_U13	60	60	2		2	T	Z	O		2	KO
		Total	**0**	**4**	**0**	**0**	**0**	**-**	**60**	**60**	**2**		**2**	**-**	**-**	**-**		**2**	**-**

Altogether in semester

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					
11	**11**	**6**	**0**	**0**	**420**	**900**	**30**	**28**	**15**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Semester 3

Obligatory courses / groups of courses Number of ECTS points …27…..

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	ECEA00014	Physics for Electronics **GK**	2	2				K1EAC _W02 K1EAC _U02	60	180	6	6	2	T	Z(lec)			3	KP
2	ECEA00007	Scientific_and_Engineering_Programming **GK**	2		2			K1EAC _W03 K1EAC _U03	60	150	5	5	2	T	Z(lec)			3	K
3	ECEA00016	Electronic_Components_and_Sensors **GK**	3	1	2			K1EAC _W04 K1EAC_U04	90	240	8	8	3	T	E(lec)			5	K
4	ECEA00006	Electronic_Technology **GK**	2		2			K1EAC _W04 K1EAC _U04	60	150	5	5	3	T	Z(lec)			3	K
5	ECEA00025	Python **GK**	1	1				K1EAC _W03 K1EAC_U03	30	90	3	3	2	T	Z(lec)			2	K
		Total	**10**	**4**	**6**	**0**	**0**	**-**	**300**	**810**	**27**	**27**	**12**	**-**	**-**	**-**	**-**	**16**	**-**

Optional courses / groups of courses (minimum …120… hours in semester, …3…. ECTS points)

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	From the university pool	Sport		4				K1EAC_K05	60	0	0		0	T	Z	O			KO
2	From the university pool	Foreign language – B2.2/C1.2		4				K1EAC_U13	60	90	3		2	T	Z	O		3	KO
		Total	**0**	**8**	**0**	**0**	**0**	**-**	**120**	**90**	**3**		**4**	**-**	**-**	**-**	**-**	**3**	**-**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Altogether in semester

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					
10	**12**	**6**	**0**	**0**	**420**	**900**	**30**	**27**	**16**

Semester 4

Obligatory courses / groups of courses Number of ECTS points …30…..

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	ECEA00010	Programming Systems & Environments **GK**	2		2			K1EAC _W03 K1EAC _U03	60	120	4	4	2	T(lec)	Z			2	K
2	ECEA00022	Introduction_to_Microcontrollers **GK**	3		2	1		K1EAC _W07 K1EAC _U07	90	240	8	8	5	T(lec)	E			4	K
3	ECEA00009	Electronic_circuits **GK**	2		2	2		K1EAC _W04 K1EAC _U04	90	210	8	8	4	T(lec)	E			5	K
4	ECEA00019	Introduction to Automation **GK**	2		1			K1EAC _W05 K1EAC_U05	45	120	3	3	2	T(lec)	Z			2	K
5	ECEA00020	Introduction to Robotics **GK**	2		1			K1EAC _W05 K1EAC_U05	45	90	3	3	2	T(lec)	Z			2	K
6	ECEA00021	Fundamentals_of_Telecommunication **GK**	2		2			K1EAC _W06 K1EAC _U06	60	120	4	4	2	T(lec)	Z			2	K
		Total	**13**	**0**	**10**	**3**	**0**	-	**390**	**900**	**30**	**30**	**17**	-	-	-	-	**17**	-

Optional courses / groups of courses (minimum …0… hours in semester, …0…. ECTS points)

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Altogether in semester

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					
13	**0**	**10**	**3**	**0**	**390**	**900**	**30**	**30**	**17**

Semester 5

Obligatory courses / groups of courses Number of ECTS points …9…..

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	ECEA00101	Computer_Networks **GK**	2		2			K1EAC _W10 K1EAC _U10	60	120	4	4	2	T	Z(lec)			2	K
2	ECEA19202	Microcontrollers **GK**	2		2	1		K1EAC _W07 K1EAC _U07	75	150	5	5	4	T	E(lec)			3	K
		Total	**4**	**0**	**4**	**1**	**0**	-	**135**	**270**	**9**	**9**	**6**	-	-	-	-	**5**	-

Optional courses / groups of courses (minimum …225… hours in semester, …21…. ECTS points; choice 3 of 5)

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University-wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	ECEA00201	Advanced Topics in Robotics **GK**	2			2	1	K1EAC _W05 K1EAC _U05	75	210	7	7	4	T	Z(lec)			4	K

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

2	ECEA00102	Digital Signal Processing **GK**	2		3			K1EAC _W07 K1EAC _U07	75	210	7	7	4	T	Z(lec)			4	K
3	ECEA00203	Artificial Intelligence and Computer Vision **GK**	2		2	1		K1EAC _W03 K1EAC _U03	75	210	7	7	4	T	Z(lec)			4	K
4	ECEA00204	Optoelectronics **GK**	2			2	1	K1EAC _W12 K1EAC _U12	75	210	7	7	4	T	Z(lec)			4	K
5	ECEA00205	Wireless systems **GK**	3		2			K1EAC _W06 K1EAC _U06	75	210	7	7	4	T	Z(lec)			4	K
		Total	**11**	**0**	**7**	**5**	**2**	**-**	**225**	**630**	**21**	**21**	**12**	**-**	**-**	**-**	**-**	**12**	**-**

Altogether in semester

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					
15	**0**	**11**	**6**	**2**	**360**	**900**	**30**	**30**	**18**

Semester 6

Obligatory courses / groups of courses Number of ECTS points …9…..

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	ECEA00103	Electroacoustics **GK**	2		2			K1EAC _W12 K1EAC _U12	60	120	4	4	2	T	Z(lec)			2	K
2	ECEA00106	Team & preengineering project			3			K1EAC_K04	75	150	5	5	2,5	T	Z			5	K
		Total	**2**	**0**	**5**	**0**	**0**	**-**	**135**	**270**	**9**	**4**	**4,5**	**-**	**-**	**-**	**-**	**7**	**-**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Optional courses / groups of courses (minimum …225… hours in semester, …15…. ECTS points; choice 3 of 5)

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	ECEA00206	Control Systems Engineering **GK**	2		3			K1EAC _W05 K1EAC _U05	75	210	7	7	4	T	E(lec)			4	K
2	ECEA00207	Embedded Systems **GK**	2		2	1		K1EAC _W07 K1EAC _U07	75	210	7	7	4	T	E(lec)			4	K
3	ECEA00208	Real Time Operating Systems **GK**	2			3		K1EAC _W03 K1EAC _U03	75	210	7	7	4	T	E(lec)			4	K
4	ECEA00209	Lasers, Fibers and Applications **GK**	2		2		1	K1EAC _W12 K1EAC _U12	75	210	7	7	4	T	E(lec)			4	K
5	ECEA00210	Communication systems and networks **GK**	2		2		1	K1EAC _W06 K1EAC _U06	75	210	7	7	4	T	E(lec)			4	K
		Total	**10**	**0**	**9**	**4**	**2**	**-**	**225**	**630**	**21**	**21**	**12**	**-**	**-**	**-**	**-**	**12**	**-**

Altogether in semester

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					
12	**0**	**14**	**4**	**2**	**360**	**900**	**30**	**30**	**16,5**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Semester 7

Obligatory courses / groups of courses Number of ECTS points …24…..

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	ECEA17105	Diploma seminar					2	K1EAC _U05	30	90	3	3	1	T	Z			2	K
2	ECEA17100	Final project			12			K1EAC _U09		360	12	12	3	T	Z			12	K
3	ECEA16001Q	Intership						K1EAC_U04		180	6	6	6	T	Z			6	K
4	PRZ000339W	Copyright	2					K1EAC_K02	30	60	2	2	1	T	Z	O			KO
5	ZMZ001048W	Entrepreneurship	2					K1EAC_K03	30	30	1	1	1	T	Z	O			KO
		Total	**4**	**0**	**12**	**0**	**2**	**-**	**90**	**720**	**24**	**24**	**12**	**-**	**-**	**-**	**-**	**20**	**-**

Optional courses / groups of courses (minimum …90… hours in semester, …6…. ECTS points; choice 2 of 9)

No.	Course/ group of courses code	Name of course/group of courses (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of course/group of courses	Way[3] of crediting	Course/group of courses			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerning scientific activities[5]	Practical[6]	Type[7]
1	ECEA00211	Electrotechnics **GK**	2		1			K1EAC _W04 K1EAC _U04	45	90	3	3	1,5	T	Z(lec)			1	K
2	ECEA00212	Medical Electronics **GK**	2				1	K1EAC _W04 K1EAC _U04	45	90	3	3	1,5	T	Z(lec)			1	K
3	ECEA00214	Electronics for Renewable Energy Sources **GK**	2				1	K1EAC _W02 K1EAC _U02	45	90	3	3	1,5	T	Z(lec)			1	K
4	ECEA00216	Virtualization and Cloud Computing **GK**	1		2			K1EAC _W03 K1EAC _U03	45	90	3	3	1,5	T	Z(lec)			1	K
5	ECEA00217	Machine learning **GK**	1			2		K1EAC _W03 K1EAC _U03	45	90	3	3	1,5	T	Z(lec)			1	K

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

6	ECEA00218	Selected topics in Artificial Intelligence **GK**	2		1			K1EAC _W03 K1EAC _U03	45	90	3	3	1,5	T	Z(lec)			1	K
7	ECEA00220	Ultrasonic technology **GK**	1		2			K1EAC _W02 K1EAC _U02	45	90	3	3	1,5	T	Z(lec)			1	K
8	ECEA00221	Speech communication **GK**	1		2			K1EAC _W02 K1EAC _U02	45	90	3	3	1,5	T	Z(lec)			1	K
9	ECEA00223	Introductiont to Radar Technology **GK**	2				1	K1EAC _W02 K1EAC _U02	45	90	3	3	1,5	T	Z(lec)			1	K
		Total	**19**	**0**	**10**	**2**	**5**	**-**	**90**	**180**	**6**	**6**	**3**	**-**	**-**	**-**	**-**	**2**	**-**

Altogether in semester

Total number of hours					Total number of ZZU hours	Total number of CNPS hours	Total number of ECTS points	Total number of ECTS points for DN classes[5]	Number of ECTS points for BU classes[1]
lec	cl	lab	pr	sem					
23	**0**	**22**	**2**	**7**	**90**	**180**	**30**	**30**	**15**

2. Set of examinations in semestral arrangement

Course / group of courses code	Names of courses / groups of courses ending with examination	Semester
MAT001653 MAT001654	1. Math - Analysis 1 2. Math - Algebra GK	1
MAT001510 FZP001127 ECEA17004	3. Math - Analysis 2 4. Physics 5. Object oriented programming	2
ECEA00016	6. Electronic_Components_and_Sensors	3
ECEA00022	7. Introduction_to_Microcontrollers	4

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

ECEA00009	8.	Electronic_circuits GK	
ECEA19102	9.	Microcontrollers	5
ECEA00206 ECEA00207 ECEA00208 ECEA00209 ECEA00210	10. 11. 12. 13. 14.	Control Systems Engineering GK Embedded Systems GK Real Time Operating Systems GK Lasers, Fibers and Applications GK Communication systems and networks GK ***(choice 3 of 5)***	6
ECEA17100	15.	Final project	7

3. Numbers of allowable deficit of ECTS points after particular semesters

Semester	Allowable deficit of ECTS points after semester
1	11
2	11
3	11
4	11
5	11
6	0
7	0

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Opinion of student government legislative body

.....	.....
Date	Name and surname, signature of student representative

.....	.....
Date	Dean’s signature

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
[2]Traditional – enter T, remote – enter Z
[3]Exam – enter E, crediting – enter Z. For the group of courses – after the letter E or Z - enter in brackets the final course form (lec, cl, lab, pr, sem)
[4]University-wide course /group of courses – enter O
[5]DN - number of ECTS points assigned to the classes related to the University's academic activity in the discipline/disciplines to which the main field of study is assigned
[6]Practical course / group of courses – enter P. For the group of courses – in brackets enter the number of ECTS points assigned to practical courses
[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

Zał. nr 5 do ZW 16/2020

FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Elektronika odnawialnych źródeł energii**
Name of subject in English:	**Electronics for Renewable Energy Sources**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**optional**
Subject code:	**ECEA00214**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				15
Number of hours of total student workload (CNPS)	60				30
Form of crediting	Crediting with grade				Crediting with grade
For group of courses mark (X) final course	X				
Number of ECTS points	**3**				
including number of ECTS points for practical (P) classes					2
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1				0,5

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. ECEA013 Electronic Components and Sensors
2. ECEA015 Electronic Circuits

SUBJECT OBJECTIVES

C1 – Acquiring knowledge about methods and properties of wind, solar, water, geothermal and biomass energy conversion

C2 – Acquiring knowledge about methods for designing and maintaining renewable energy setups with the use of passive and active systems, including techniques used for storing such type of energy

C3 – Achieving ability to search and present information about selected topics of electronics for renewable energy sources

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 – describes and characterises traditional and renewable energy resources
PEU_W02 – defines and describes wind and solar energy systems
PEU_W03 – characterises different forms of energy storage
PEU_W04 – defines and describes water, geothermal, biomass and hydrogen energy systems
PEU_W05 – characterises current trends in renewable energy systems

relating to skills:
PEU_U01 – retrieves and interprets technical information about new electronic solutions for renewable energy sources
PEU_U02 – prepares and presents information about electronic for renewable energy sources

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec1	Introduction and characterization of the primary energy resources.	2
Lec2	Conventional energy systems in comparison to the renewable energy sources.	2
Lec3	Energetic and world pollution problems.	2
Lec4	The use of wind and solar energy systems.	2
Lec5	Passive and active solar energy systems.	2
Lec6	Active solar energy systems – advantages and disadvantages, applications, definition of the solar chimney.	2
Lec7	Systems supporting the use of renewable energy, different forms of energy storage, thermal and chemical energy storage.	2
Lec8	Photovoltaic cells – development trends, hybrid solutions and energy storage systems.	2
Lec9	Selection and characteristics of photovoltaic components.	2
Lec10	Geothermal and water energy.	2
Lec11	Biomass, biogas, the role of hydrogen as an energy carrier.	2
Lec12	Fuel cells.	2
Lec13	Hybrid vehicles, constructions of diesel-electric, electromechanical systems with kinetic and hydraulic energy storage systems.	2
Lec14	Development trends of renewable energy systems including legal regulations in different countries and UE programs.	2
Lec15	Possible modifications of traditional energy systems, development trends of renewable energy systems.	2
	Total hours	**30**

Seminar		**Number of hours**
Sem1	Introduction. Choice of the content for individual seminar presentations.	1
Sem2	Individual consultations. Choice of information sources.	2
Sem3	Preliminary presentations. Discussions on future work.	4
Sem4	Final presentations.	8
	Total hours	**15**

TEACHING TOOLS USED
N1. Traditional lectures with the use of multimedia presentations N2. Consultations N3. Public presentation and discussion N4. Individual work

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating learning outcomes achievement
F1	PEU_W01 – PEU_W05	Final test
F2	PEU_U01, PEU_U02	Multimedia presentation, involvement in discussion
C = 2/3*F1 + 1/3*F2 (positive grade under condition: F1>2 & F2>2)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Kazmerski L.L.: Photovoltaics. A Review of Cell and Module Technologies, Renewable & Sustainable Energy Reviews 1, 1997, s. 71.
[2] Markvart T., Castaner L.: Practical Handbook of Photovoltaics, Elsevier 2003.
[3] Tiwari G.N., Mishra R.K.: Advanced renewable energy sources. RSC Publishing, Cambridge 2012.

SECONDARY LITERATURE:

[1] Bogdanienko J.: Odnawialne źródła energii, PWN, Warszawa, 1989.
[2] Lewandowski W.M.: Proekologiczne odnawialne źródła energii, WNT, Warszawa, 2006.
[3] Klugmann-Radziemska E.: Fotowoltaika w teorii i praktyce, BTC, Legionowo, 2010.
[4] Pluta Z.: Podstawy teoretyczne fototermicznej konwersji energii słonecznej, Oficyna Wyd. Politechniki Warszawskiej, Warszawa 2000.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Prof. Janusz Mroczka, Ph.D., D.Sc., janusz.mroczka@pwr.edu.pl

Zał. nr 5 do ZW 16/2020

FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Uczenie maszynowe**
Name of subject in English:	**Machine Learning**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**optional**
Subject code:	**ECEA00217**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			30	
Number of hours of total student workload (CNPS)	30			60	
Form of crediting	crediting with grade			crediting with grade	
For group of courses mark (X) final course	**x**				
Number of ECTS points	**3**				
including number of ECTS points for practical (P) classes				2	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,5			1	

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of methodology and programming techniques
2. Knowledge of fundamental computational and simulation techniques

SUBJECT OBJECTIVES

C1: To be familiar with fundamental machine learning methods and their applications

C2: To be skilled in solving the selected machine learning problems, and in programming and testing the selected computational algorithms in Matlab

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01: unsupervised learning.
PEU_W02: supervised learning.
PEU_W03: applications of machine learning methods in pattern recognition, signal and image processing, data mining, and spectral analysis.

relating to skills:
PEU_U01: formulate a machine learning problem, test its properties and select the right algorithm for solving it,
PEU_U02: efficiently code and test machine learning algorithms in a computational environment,
PEU_U03: can use the Matlab toolboxes, such as *Statistics, Signal Processing, Image Processing, Bioinformatics.*

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Introduction, requirements, machine learning concepts, examples	2
Lec 2	Dimensionality reduction	2
Lec 3	Clustering	2
Lec 4	Classification	2
Lec 5	Linear models	2
Lec 6	Kernel machines	2
Lec 7	Applications	2
Lec 8	Test	1
	Total hours	**15**

Project		**Number of hours**
Pr 1	Various applications of machine learning methods, including: pattern recognition, image processing, signal processing, spectral analysis, data mining, bioengineering, etc.	30
	Total hours	**30**

TEACHING TOOLS USED

N1. Classroom (chalkboard).
N2. Toolboxes in Matlab.
N3. Consultation hours
N4. Homework – preparation to project tasks.
N5. Homework – self-studying and preparation to the test.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 – PEU_W03	final test
F2	PEU_U01 – PEU_U03	note from a project task
P = 0.51*F1 + 0.49*F2 (F1 > 2 i F2 > 2)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

1. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006,
2. D. Barber, Bayesian Reasoning and Machine Learning, Cambridge University Press, 2012
3. J. Hopcroft, R. Kannan, Foundations of Data Science, E-book, 2014,
4. Alex Smola and S.V.N. Vishwanathan, Introduction to Machine Learning, Cambridge University Press, 2008

SECONDARY LITERATURE:

1. E. Alpaydin, Introduction to Machine Learning, The MIT Press, Cambridge, Massachusetts, 2010
2. A. Cichocki, R. Zdunek, A. H. Phan, S.-I. Amari, Nonnegative Matrix and Tensor Factorization: Applications to Exploratory Multi-way Data Analysis and Blind Source Separation, Wiley and Sons, UK, 2009
3. M. Krzyśko, W. Wołyński, T. Górecki, M. Skorzybut, Systemy uczące się: rozpoznawanie wzorców, analiza skupień i redukcja wymiarowości, Wydawnictwo Naukowo-Techniczne, Warszawa, 2008
4. J. Koronacki, J. Ćwik, Statystyczne systemy uczące się, Akademicka Oficyna Wydawnicza EXIT, Warszawa 2008

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Rafał Zdunek, rafal.zdunek@pwr.edu.pl

Zał. nr 5 do ZW 16/2020

FACULTY OF ELECTRONICS (W4)

SUBJECT CARD

Name of subject in Polish:	**Technika ultradźwiękowa**
Name of subject in English:	**Ultrasonic Technology**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**optional**
Subject code:	**ECEA00220**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	30		60		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course	X				
Number of ECTS points	**3**				
including number of ECTS points for practical (P) classes			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,5		1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

C1 - Acquisition of knowledge regarding physical phenomena and processes occurring in ultrasound technology and the ability to determine the basic physical quantities in the field of ultrasound.
C2 - Acquisition of knowledge concerning principles and create equivalent schemes of ultrasonic transducers are designed to operate in different media.
C3 - Acquiring skills to perform ultrasonic measurements of fundamental physical parameters, as well as to operate ultrasonic devices assigned for nondestructive testing.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Student is called, describe and understand the basic concepts and theoretical issues associated with the ultrasound technique.

PEU_W02 Student knows the principles of ultrasound sources and create their alternative schemes designed to operate at different media.

relating to skills:

PEU_U01 Student performs ultrasonic measurements of fundamental physical parameters.

PEU_U02 Student operates ultrasonic devices designed for nondestructive testing.

PEU_U03 Student is able to elaborate report/protocol from measurements and analysis.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1 Lec 2 Lec 3	The propagation of ultrasonic waves in different media. The parameters of the ultrasound field. Crossing of ultrasonic waves the media boundaries.	6
Lec 4 Lec 5	Attenuation of ultrasonic waves in different media. Systematic effects of ultrasound.	4
Lec 6 Lec 7 Lec 8	Flow ultrasonic source. Piezomagnetic and piezoelectric transducers. Other sources of ultrasound. The rules for determining equivalent circuits of ultrasonic transducers. Knowledge test.	5
	Total hours	**15**

	Laboratory	**Number of hours**
Lab 1	Introductory meeting. Overview of the Staff Regulations, principles of usage for equipment on laboratory stands, how to prepare for the laboratory exercises and how to work up reports.	3
Lab 2	Investigation of ultrasonic wave dispersion.	3
Lab 3	Measurement of propagation velocity of ultrasonic waves in liquids.	3
Lab 4	Measurement of propagation velocity and attenuation of ultrasonic waves in solids.	3
Lab 5	Measurement of radiation force of ultrasound in water.	3
Lab 6	Measurement of efficiency and calculation of equivalent scheme for piezomagnetic transducer.	3
Lab 7	Measurement of distribution of surface vibrations of ultrasonic transducer.	3
Lab 8	Measurements of electromechanical properties of piezoelectric transducer.	3
Lab 9	Measurement of directivity pattern of aerolocation transducer.	3
Lab 10	Recovering term.	3
	Total hours	**30**

TEACHING TOOLS USED

N1. Lecture by means of the plate and slide.
N2. Consultation.
N3. Self-study and prepare for tests.
N4. Laboratory instructions on-line.

N5. Self-study and prepare for laboratory exercises and reports.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01, PEU_W02	Test
F2	PEU_U01, PEU_U02	Evaluation of theoretical knowledge about laboratory exercises
F3	PEU_U03	Evaluation of preparation of reports and correctness of analysis
P1: Successful completion test. Mark on the basis of achieved scores. P2: Positive scores from laboratory classes; P2 = (F2 + F3)/2 C = 0.7*P1+0.3*P2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] E. Talarczyk, Podstawy techniki ultradźwięków, Wyd. PWr., Wrocław, 1990 (an English translation of the laboratory script for students: Fundamentals of Ultrasonic Technology).
[2] Golanowski, J., Gudra, T., Podstawy techniki ultradźwięków - ćw. lab., skrypt PWr., Wrocław 1990 (an English translation of the laboratory script for students: Fundamentals of Ultrasonic Technology – Laboratory Exercises).
[3] D. Ensminger, L. J. Bond, Ultrasonics. Fundamentals, Technologies and Applications, CRC Press, 2012.

SECONDARY LITERATURE:

[1] A. Puskar, The use of high intensity ultrasonics, ELSEVIER, Amsterdam-Oxford- New York, 1982.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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prof. dr hab. inż. Tadeusz Gudra, tadeusz.gudra@pwr.edu.pl
mgr inż. Tomasz Świetlik, tomasz.swietlik@pwr.edu.pl

Faculty of Electronics (W4) / Department of Cybernetics and Robotics (K29W04D02)

SUBJECT CARD

Name of subject in Polish: **Wybrane zagadnienia sztucznej inteligencji**
Name of subject in English: **Selected topics in Artificial Intelligence**
Main field of study (if applicable): **Electronic and Computer Engineering (ECE)**
Profile: **academic**
Level and form of studies: **1st level, full-time**
Kind of subject: **obligatory**
Subject code: **ECEA00218**
Group of courses: **Yes**

	Lecture	Exercise	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	30		60		
Form of crediting	Crediting with grade		Crediting with grade		
For group of courses mark (X) the final course	X				
Number of ECTS points	3.0				
including number of ECTS points for practical (P) classes			2.0		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.5		1.5		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge about algebra
2. Skill in programming in Python

SUBJECT OBJECTIVES

C1. Learn selected basic artificial intelligence problem-solving paradigms and algorithms.

C2. Gain a practical ability to use some artificial intelligence programming environments to solve practical problems.

SUBJECT LEARNING OUTCOMES

Relating to knowledge:

PEU_W01 - Knows some specialized artificial representation schemes and associated algorithms.

Relating to skills:

PEU_U01 - Can write programs in selected artificial intelligence languages and environments.

PROGRAM CONTENT		
Lecture		**Number of hours**
Lec1	Introduction to machine learning.	3
Lec2	Selected machine learning algorithms.	3
Lec3	Introduction to deep learning.	3
Lec4	Selected deep learning algorithms.	3
Lec5	Dataset augmentation, optimizers, over-fitting problem.	3
	Total hours:	15

Laboratory		**Number of hours**
Lab1	Introduction to script language.	3
Lab2	Classification with selected machine learning algorithms.	3
Lab3	Classification wit selected deep learning algorithms.	3
Lab4	Dataset augmentation.	3
Lab5	Prediction models.	3
Lab6	Mini project.	15
	Total hours:	30

TEACHING TOOLS USED
N1. Traditional lecture with or without use of multimedia tools.
N2. Laboratory, solving of engineering problems with use of a computer.
N3. Independent work, preparation to laboratories.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation: F — forming (during semester), C — concluding (at semester end)	Learning outcome code	Way of evaluating learning outcome achievement
F1	PEU_W01	Test
F2	PEU_U01	Laboratory grade
P = 0.6*F1 + 0.4*F2 (in order to pass the course, both F1 and F2 must be positive)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Russell, Norvig: Artificial Intelligence A Modern Approach Third Edition, Prentice-Hall, 2010
[2] Goodfellow, Bengio, Courville: Deep Learning, MIT Press, 2016
[3] Lutz: Learning Python Fifth Edition, O'Reilly, 2013

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Wojciech Domski, wojciech.domski@pwr.edu.pl

FACULTY OF ELECTRONICS (W4)

SUBJECT CARD

Name of subject in Polish …… Wprowadzenie do Techniki Radarowej
Name of subject in English …… Introduction to Radar Technology
Main field of study (if applicable): Electronic and Computer Engineering (ECE)
Specialization (if applicable): ……..
Profile: academic
Level and form of studies: 1st level, full-time
Kind of subject: optional
Subject code … ECEA00223
Group of courses YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				15
Number of hours of total student workload (CNPS)	45				45
Form of crediting	crediting with grade*				crediting with grade
For group of courses mark (X) final course	x				
Number of ECTS points	**3**				
including number of ECTS points for practical classes (P)					0,5
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1				0,5

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1 Getting the knowledge concerning basics of radar technology
C2 Gaining basic skills for discriminating between different types of radar systems
C3 Getting the knowledge concerning meaning and functioning of single parts of a radar system
C4 Developing an understanding of the application range of radar systems
C5 Gaining basic skills to search selective knowledge on a given topic, prepare such a presentation that would enable to show the listeners the issue

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 – knows basics of radar technology and EM wave propagation.
PEU_W02 – understands how radar performance is affected by different propagation scenarios.
PEU_W03 – knows common antenna types used for radar systems.
PEU_W04 – knows common radar system types and their characteristics.
PEU_W05 – has basic knowledge of transmitter and receiver architectures.
PEU_W06 – knows common methods for processing range, Doppler and angular information.

PEU_W07 – understands what radar systems can be used for.

relating to skills:
PEU_U01 – is able to calculate and analyse the radar equation.
PEU_U02 – is able to determine the scattering behavior of basic scatterers.
PEU_U03 – is able to process range, Doppler and angular information of a radar.
PEU_U04 – is able to extend knowledge of a given field of radar technology, prepare a presentation, critically evaluate technical and scientific solutions.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1,2	Organizational matters. Radar basics: Principle, quantities, history	4
Lec 3	Electromagnetic wave propagation	2
Lec 4	Radar equation: Point and extended targets, detection probability	2
Lec 5	Radar cross-section: Definition, basic scatterers, measurement	2
Lec 6	Radar antennas: Basics, quantities, antenna types	2
Lec 7,8	Radar system types: Pulse, CW, FMCW, SFCW	4
Lec 9	Transmitter and receiver architectures	2
Lec 10	Range and Doppler processing	2
Lec 11, 12	Array signal processing: Monopulse, Beamforming, High Resolution	4
Lec 13	Advanced topics: Polarimetry, passive and bistatic radar	2
Lec 14	Radar applications: Naval, Automotive, Emerging	2
Lec 15	Review	2
	Total hours	**30**

Seminar		**Number of hours**
Sem 1	Organization of the seminar, division of topics. Radar basics: Principle, quantities, history	1
Sem 2-5	Group work, preparation of seminar and discussion moderated by the teacher	10
Sem 6-7	Each groups presents their seminar	4
	Total hours	15

TEACHING TOOLS USED

N1. Traditional and on-line lectures with multimedia presentations
N2. Consultations.
N3. Student's own work – self-studies and preparations for final test.
N4. Problem-oriented discussion
N5. Homework assignments

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 - PEU_W07 PEU_U01 - PEU_U05	Final test
F2	PEU_W01 - PEU_W07 PEU_U01 - PEU_U05	Involvement in the discussion; Homework assignments
P = 0.8 * F1 + 0.2 * F2; both F1 and F2 must be positive		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] M. Skolnik, "Radar Handbook, Third Edition", McGraw-Hill Education, 2008, ISBN 0071485473

[2] H. Griffiths, G. W. Stimson, C. Baker, D. Adamy, "Stimson's Introduction to Airborne Radar", SciTech Publishing, 2013, ISBN 1613530226

[3] C. A. Balanis, "Antenna Theory: Analysis and Design", John Wiley & Sons, 2012, ISBN 1118585739

[4] E. F. Knott, J. F. Schaeffer, M. T. Tulley, "Radar Cross Section", SciTech Publishing, 2004, ISBN 1891121251

SECONDARY LITERATURE:

https://www.microwaves101.com/

https://www.radartutorial.eu/index.po.html

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Thomas Dallmann, thomas.dallmann@fhr.fraunhofer.de
Adam Narbudowicz, adam.narbudowicz@pwr.edu.pl

FACULTY OF ELECTRONICS (W4)

SUBJECT CARD

Name of subject in Polish:	**Komunikacja głosowa**
Name of subject in English:	**Speech Communication**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**optional**
Subject code:	**ECEA00221**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	30		60		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course	X				
Number of ECTS points	**3**				
including number of ECTS points for practical (P) classes			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,5		1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

C1 - Acquiring the basic knowledge regarding the phenomenon description and the processes taking place during the transmission, coding and synthesis of speech.
C2 - Acquiring the skills of assessment of coding role in speech quality.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Student knows the basic issues from speech acoustics.
PEU_W02 Student knows the basic issues speech signal coding and vocoders and speech synthesis.
PEU_W03 Student knows the basic issues speech recognition, speaker recognition and human-computer speech communication.
PEU_W04 Student knows the rules of selection and usage of measurement techniques for the evaluation of quality transmission of speech signal.

relating to skills:

PEU_U01 Student can process the analog sound signal into digital form and proceed the analysis of characteristics in time and frequency domains.
PEU_U02 Student can measure the basic parameters of time, frequency and LPC domains.
PEU_U03 Student can compare and assess the audio and video coding and compression methods.
PEU_U04 Student can make the quality assessment measurement.
PEU_U05 Student can use the TTS tools.
PEU_U06 Student can plan and use the functions of speech and speaker recognition systems.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Introduction, curriculum and requirements of the lectures etc.	1
Lec 2, Lec 3	Speech as information carrier. Mechanism of speech production.	2
Lec 4 - Lec 9	Speech coding and compression. Vocoders. Speech synthesis.	6
Lec 10 - Lec 13	Speech recognition. Speaker recognition. Man-machine voice communications.	4
Lec 14, Lec 15	Assessment of speech quality. VoIP.	2
	Total hours	**15**

Form of classes - laboratory		**Number of hours**
Lab 1	Introduction to laboratory.	2
Lab 2, Lab 3	The acquisition of speech signals and analysis of time and frequency parameters of these signals.	4
Lab 4 – Lab 6	Methods of spectral, time and LPC analysis speech signals.	6
Lab 7 – Lab 9	Coding (compression) of speech signals.	6
Lab 10, Lab 11	Methods of the assessment speech quality.	4
Lab 12	Automatic phonetic transcription. Synthesis of speech signals.	2
Lab 13 – Lab 15	Speech and speakers identification systems.	6
	Total hours	**30**

TEACHING TOOLS USED

N1. Lectures with the multimedia presentations.
N2. Tutorials.
N3. The preparation for the test – students own work.
N4. Tests checking the readiness for laboratory classes.
N5. The preparation for laboratory classes – students own work.
N6. Reports of laboratory classes – students own work

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 - PEU_W04	Test
F2	PEU_U01 - PEU_U06	Oral answers, written tests, reports of laboratory classes
P1: Successful completion test. Mark on the basis of achieved scores; P1 = F1; P2: Positive scores from laboratory classes; P2 = F2; C = ¾F1 + ¼ F2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] J. Blauert, Communication Acoustics, Springer Verlag 2005.
[2] Rabiner L., Bing-Hwang J. „Fundamentals of Speech Recognition“ Prentice Hall 1993.
[3] R. Tadeusiewicz, *Sygnał mowy*, WKiŁ, 1988.
[4] Basztura Cz., *Źródła, sygnały i obrazy akustyczne*, WKiŁ, Warszawa 1988.
[5] Makowski R. „Automatyczne rozpoznawanie mowy – wybrane zagadnienia”, Oficyna Wydawnicza Politechniki Wrocławskiej 2011.
[6] ITU Recommendation.

SECONDARY LITERATURE:

[1] P. Vary, R. Martin, *Digital Speech Transmission*, John Wley & Sons Ltd, 2005.
[2] W. C. Chu, *Speech Coding Algorithms*, Wiley-Interscience, 2003.
[3] ETSI Recommendation.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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Piotr Staroniewicz, piotr.staroniewicz@pwr.edu.pl

FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Praca dyplomowa**
Name of subject in English:	**Final Project**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA17100**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar	
Number of hours of organized classes in University (ZZU)						0
Number of hours of total student workload (CNPS)						360
Form of crediting						
For group of courses mark (X) final course						
Number of ECTS points						**12**
including number of ECTS points for practical (P) classes						10
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)						3

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1: Demonstrate the knowledge and skills acquired during studies

C2: Preparation for the final exam.

C3: Development of creative thinking and taking action. Acquisition of competence appropriate to determine the priorities for the implementation of selected task.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

relating to skills:
Thesis should demonstrate the student has a majority of the following skills:
PEU_U01: Can obtain information from literature, databases and other sources. Can integrate them, make interpretation and critically evaluate.

PEU_U02: Able to plan and carry out experiments, including measurements and computer simulations. Able to interpret the results and draw conclusions.

PEU_U03: Able to formulate and solve problems of analytical methods, simulations and experimental.

PEU_U04: Can formulate and test hypothesis related to the research and engineering problems.

PEU_U05: Able to integrate knowledge from different fields and disciplines. Able to apply a system approach, taking into account the non-technical aspects – such as economic.

PEU_U06: Able to assess the usefulness and the usability of new developments (techniques and technologies) in the discipline represented.

PEU_U07: Able to analyze and evaluate the functioning existing technical solutions – in the scope of engineering disciplines represented. Can make enhancement/improvement of existing technologies.

PEU_U08: Able to interpret the obtained results, draw appropriate conclusions and formulate recommendations

PEU_U09: Can compose a thesis in accordance with the formal requirements.

PEU_U10: Can, using a conceptually new methods – to solve complex engineering tasks specific to the engineering disciplines represented, including unusual tasks.

PEU_U11: Can – according to preset specifications, taking into account the non-technical aspects – design and implement complex device, object, system, or process-related engineering discipline represented using appropriate methods, techniques and tools, if necessary – adapt for this purpose existing or developing new tools.

PEU_U12: Able to think and act in a creative and enterprising ways.

relating to social competences:
PEU_K01 To think and act in a creative way. Able to set priorities.

TEACHING TOOLS USED

N1 Individual work
N2 Consultation

EVALUATION OF SUBJECT LARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_U01 – PEU_U12	Rating thesis by the supervisor
F2	PEU_U01 – PEU_U12	Rating thesis by the reviewer

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Adjusted individually to the subject

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Prof. dr hab. inż. Krzysztof Abramski (krzysztof.abramski@pwr.wroc.pw)

FACULTY OF ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Programowanie obiektowe**
Name of subject in English:	**Object Oriented Programming**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA17004**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	90		90		
Form of crediting	credited with grade		credited with grade		
For group of courses mark (X) final course	X				
Number of ECTS points	**5**				
including number of ECTS points for practical (P) classes	-		2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1		2		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. K1ECE _W07, K1ECE _U07

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SUBJECT OBJECTIVES

C1 The student would be introduce in the basis of object oriented programming, its engineering and methodology

C2 The student would know how to prepare program source code using object oriented approach

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Student knows the idea of the object oriented approach.

PEU_W02 Can explain the fundaments of object oriented methodology as the tool of the comprehending the real world.

PEU_W03 Can know an idea of object oriented methodology based on Unified Modeling Language (UML).

PEU_W04	Student knows basic tools and paradigms of the object oriented approach.
PEU_W05	Student knows basic programming tools on the exampled object oriented programming C++ language.
Relating to skills:	
PEU_U01	Can independently formulate and use the technology of the object oriented programming.
PEU_U02	Can create and execute the parts of the source code containing definitions of constructors both in the basis and in the derived classes.
PEU_U03	Can create and execute the parts of the independently drawn up source code containing virtual functions and overloaded operators.

PROGRAM CONTENT		
Lecture		**Number of hours**
Lec1	Introduction. Object oriented approach – a general idea.	2
Lec2	Presentation of the main application of the object oriented approach (project management, etc.) and the nowadays object oriented programming languages	2
Lec3	Object oriented programming language C++. Main paradigms, Constructors and destructors.	2
Lec4	Gadgets in C++. Default arguments, references, complex declarators, modificators, etc. A copy constructor and the assignment operator.	2
Lec5	Assessment of the main nowadays object oriented programming languages: C++, C# and Java. Microsoft .NET framework.	2
Lec6	Object oriented programming language Java. Main ideas. Packages and implementations.	2
Lec7	Object oriented programming language C#. Main ideas. Interfaces and garbage collection.	2
Lec8	Object oriented approach. Encapsulation and inheritance. Virtual functions and abstract classes.	2
Lec9	Creation of the simple class. Encapsulation. Static data and functions. Operator overloading as the global and member function. Operator overloading in C++ and C#.	2
Lec10	Inheritance and derived classes. Multiply inheritance in C++ and interfaces in C# and Java.	2
Lec11	C# language. Classes, expressions and operators.	2
Lec12	Inheritance, interfaces, iterators, exceptions handling, processes and threads	2
Lec13	Virtual functions and abstract classes. Basis of the Unified Modeling Language (UML). Class diagrams. Examples, case studies.	4
Lec14	Summary lecture.	2
	Total hours	30

Laboratory		**Number of hours**
L1,2	Getting acquainted with the programming platform. Simple program in	4

	structural methodology.	
L3-6	Application of the object oriented approach for the individual simple program in C++ agreed with the lecturer	8
L7-9	Individual program in C++ agreed with the lecturer	6
L10-12	Application of the object oriented approach for the individual simple program in C# or Java agreed with the lecturer	6
L13-15	Individual program in C# or Java agreed with the lecturer	6
	Total hours	**30**

TEACHING TOOLS USED
N1. LCD Projector, blackboard N2. Computer with an access to the Internet, Integrated Development Environment *(*IDE), MS .NET Framework, MS Office

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01-W05	Lectures credited with grade
F2	PEU_U01-U03	Program code presented and credited with grade
P = 0.6 * F1 + 0.4 * F2 (subject to credit all forms)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Stroustrup B., The C++ programming language, NJ, Addison-Wesley, 2013.

[2] Sahay S., Object oriented programming with C++, 2nd edition, New Delhi : Oxford University Press, 2012.

[3] Eckel, B., Thinking in Java, Upper Saddle River: Prentice Hall, 2006

[4] Hejlsberg A., Torgersen M., Wiltamuth S., Golde P., The C# Programming Language (3rd Edition), Microsoft .NET Development Series

[5] Malik. D. S., Introduction to C++ programming, Boston, MA: Course Technology, Cengage Learning, 2009.

[6] Actual documentation for C++, C#, Java

SECONDARY LITERATURE:

[1] Kubik T., Kruczkiewicz Z., UML and service description languages: information systems modelling, Wrocław University of Technology, PRINTPAP, 2011.

[2] Martin J., Odell J.J., Podstawy metod obiektowych, WNT, 1997

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Dr inż. Marcin Markowski, marcin.markowski@pwr.edu.pl

Zał. nr 5 do ZW 16/2020

FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Seminarium dyplomowe**
Name of subject in English:	**Diploma seminar**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA17105**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)					30
Number of hours of total student workload (CNPS)					60
Form of crediting					crediting with grade
For group of courses mark (X) final course					X
Number of ECTS points					**2**
including number of ECTS points for practical (P) classes					2
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)					1

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

C1 Acquisition of skills in searching selected knowledge necessary to create own original solutions

C2 Gaining skills to prepere clear and communicative presentation to the audience in order to pass original concepts and solutions.

C3 Acquisition of the skills to create discussion that in factual and substantive way is able to justify and defend his position.

C4 Acquisition of literacy work of presenting their own achievements, including presentation of the subject against the world level.

C5 Excitation of creative approach that allows setting priorities for the implementation of a task, to motivate to the collaboration, understanding of the communication to the public.

SUBJECT LEARNING OUTCOMES

relating to knowledge:
…
relating to skills:
PEU_U01 Able to make a presentation with the solution and results

PEU_U02 Able to discuss objectively oryginal ideas and solutions

PEU_U03 Able to critically evaluate the scientific and technical solutions others

relating to social competences:
PEU_K01 To think and create in a creative way. Able to prioritize appropriately to fulfill the given task. He knows the rules of group work managing a small team taking responsibility for the results of his work. Is aware of social impact of engineering activities and related accountability for decissions. He understands the need to provide public information and options on the achievements of technology and other aspects of a technical college graduate.

PROGRAMME CONTENT

	Seminar	**Number of hours**
Sem 1	Selection of the presentation and discussion with the supervisor the areas of the seminar	2
Sem 2	Presentations and discussions	28
Sem 3		
	Total hours	**30**

TEACHING TOOLS USED

N1. A multimedia presentation individually or in small groups

N2. Talk problematic in the group

N3. Own work

N4. Consultation

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_U01 – PEU_U03 PEU_K01	Rate of presentation, discussion and attitudes including attendance
P = F1		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Adjusted individually to the topic presented.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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Zał. nr 5 do ZW 16/2020

FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Mikrokontrolery**
Name of subject in English:	**Microcontrollers**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**optional**
Subject code:	**ECEA19202**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30	15	
Number of hours of total student workload (CNPS)	90		60	60	
Form of crediting	Egzaminaton		Crediting with grade	Crediting with grade	
For group of courses mark (X) final course	x				
Number of ECTS points	**5**				
including number of ECTS points for practical (P) classes			2	1	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1		2	1	

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Introduction to Microcontrollers.

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SUBJECT OBJECTIVES

C1. Acquiring knowledge of the microcontroller architecture
C2. Gaining basic knowledge about the basic building blocks of peripherals implemented in microcontroller systems
C3. Acquiring a basic understanding of multitasking
C4. Gaining the ability to use advanced microcontroller modules

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:

PEU_W01 - knows the basic principles of design of microprocessor systems

PEU_W02 - has the knowledge to microcontroller selection for the required output and peripheral circuits offered to a given application

PEU_W03 - knows the principles of designing and running the code performing specific tasks on the selected hardware platform

PEU_W04 - has knowledge of integrating a microcontroller with external systems, digital and analog

Relating to skills:

PEU_U01 - is able to select and properly use effective development environment for RISC microcontroller,

PEU_U02 - knows how to prepare, create, validate and deploy testing and functional software of microcontrollers,

PEU_U03 - can find information about the parameters and characteristics of a chosen microcontroller

PROGRAMME CONTENT		
Lecture		**Number of hours**
Lec1	Architecture of microcontrollers.	2
Lec2 Lec3	Microcontrollers: 8- and 16-bit families	4
Lec4	Microcontrollers: 32- and 64-bit families	2
Lec5	The family of ARM microcontrollers. Similarities and differences between the subfamilies Cortex-M, Cortex-R and Cortex-A	2
Lec6	Overview of the microcontroller market. Deposition of microcontroller chips used in electronic devices	2
Lec7	Interrupts in microcontrollers. Nested interrupts. NVIC and GIC blocks	2
Lec8	Multitasking in microcontrollers. Implementation of cooperative and preemptive multitasking	2
Lec9	The mid semester test	2
Lec10	Methods for reducing power consumption in microprocessor systems. Microprocessors with minimal power consumption.	2
Lec11 Lec12 Lec13 Lec14	Advanced microprocessor peripherals. Advanced timers and counters. Systems with direct memory access DMA. External memory interfaces: SRAM, DRAM, and the like. Fast serial interfaces: USB, Ethernet. Interfaces video and audio signals.	8
Lec15	Data acquisition	2
	Total hours	**30**

Laboratory		**Number of hours**
La1	Introduction. The organization and principles of the Integrated Development Environment and the microcontroller module.	2

La2	The impact of variable declarations on the speed of the program and computing.	2
La3	Principles of cooperation CMSIS library programs and libraries microcontroller manufacturers. Read / write states of the GPIO ports	2
La4	Signal generation by the microcontroller timer/counter.	2
La5	Hardware pulse width modulation (PWM).	2
La6	Rules of the microcontroller interrupts, the interrupt priority and the interrupt nesting. The use of standard CMSIS subroutines.	2
La7	Measuring the pulse widh factor.	2
La8	Voltage measurements using the microcontroller A/D converter.	2
La9	DMA transfer to/from peripheral device.	2
La10	The shaping of analog signal. D/A converter.	2
La11	UART - serial data transmission.	2
La12	Cooperation between microcontroller and measurement sensors using I2C-Bus interface.	2
La13	Serial data interface (SPI) for communication between the microcontroller and the LCD chip.	2
La14	CMSIS library - implementation of digital filter.	2
La15	The additional lab - finalizing uncomplited tasks.	2
	Total hours	**30**

Project		**Number of hours**
Pr1	Introduction to the course. Discussion of exemplary projects topics.	3
Pr2	Choice of projects themes.	2
Pr3	Problematic discussion	2
Pr4 Pr5	Presentation and discussion of proposed solutions.	4
Pr6	Problematic discussion	
Pr7 Pr8	Presentation of the implemented solutions.	4
	Total hours	**15**

TEACHING TOOLS USED
N1. Lectures using multimedia presentations and whiteboard. N2. Laboratory classes - discussions on solutions applied. N3. Class Project - problems discussion N4. Consultations N5. Self - preparation for laboratory classes N6. Self - preparing the project N7. Self -study and preparation for final test

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 – PEU_W04	Final exam

F2	PEU_U01 – PEU_U03	Tests and report laboratory exercises
F3	PEU_U01 – PEU_U03	Presentations and implementation of the project
P = 0.5*F1+0.25*F2+0.25*F3, (positive grade under condition: F1>2 i F2>2 i F3>2)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Technical documentation of Cortex-M family microcontrollers: Atmel, Cypress, Freescale, NXP (Philips Semiconductors), Silicon Labs, STMicroelectronics, Texas Instruments (available in Internet).

[2] S. Furber: ARM System-on-chip architecture. 2 edition, Addison-Wesley Publishers, 2000, ISBN - 978-0201675191

[3] N. Sloss, D. Symes, Ch. Wright: ARM system Developer's Guide. Morgan Kaufmann Publishers, 2004, ISBN-1-55860-874-5

[4] D. Seal: ARM Architecture Reference Manual. Second Edition, Addison-Wesley, 2001.

[5] J. Yiu: The Definitive Guide to the ARM Cortex-M0. Elsevier Inc. 2011.

[6] J. Yiu: The Definitive Guide to the ARM Cortex-M3. Second Edition. Elsevier Inc. 2010.

SECONDARY LITERATURE:

[1] Applications of Cortex-M0/M0+/M3/M4/M7 family (available in Internet).

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Grzegorz Budzyń, grzegorz.budzyn@pwr.edu.pl
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Zał. nr 5 do ZW 16/2020

Faculty of Electronics (W4) / Department of Field Theory, Electronic Circuits and Optoelectronics (K35W04D02)

SUBJECT CARD

Name of subject in Polish: **Układy elektroniczne**

Name of subject in English: **Electronic Circuits**

Main field of study (if applicable): **Electronic and Computer Engineering (ECE)**

Profile: **academic**

Level and form of studies: **1st level, full-time**

Kind of subject: **obligatory**

Subject code: **ECEA20009**

Group of courses: **Yes**

	Lecture	Exercise	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30	30	
Number of hours of total student workload (CNPS)	90		90	60	
Form of crediting	Examination		Crediting with grade	Crediting with grade	
For group of courses mark (X) the final course	X				
Number of ECTS points	8.0				
including number of ECTS points for practical (P) classes			3.0	2.0	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.0		2.0	1.0	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Circuit theory at the intermediate level

SUBJECT OBJECTIVES

C1. Earning the knowledge in construction, way of operation and properties of basic electronic circuits as well as trends in development of them.

C2. Getting ability in design of elementary electronic circuits

C3. Familiarize with SPICE-like systems for electronic circuits analysis

C4. Acquiring the ability to assemble and run simple electronic systems

C5. Gaining skills in measurements basic parameters of electronic system using multimeter, scope, function generator

C6. Doskonalenie umiejętności sporządzenia opisu przeprowadzonych eksperymentów w przejrzystej formie

SUBJECT LEARNING OUTCOMES
Relating to knowledge: PEU_W01 - The student explains the construction and principle of operation of basic electronic circuits; The student describes the basic techniques of analysis and design of electronic circuits (including computer-aided design techniques); The student knows the development trends of analog electronic systems, including integrated circuits Relating to skills: PEU_U01 - The student is able, in accordance with the given specification and using appropriate methods, techniques and tools (including computer simulations), to design a simple electronic system; PEU_U02 - The student is able to implement a simple electronic circuit, run it and measure its basic parameters and collect the results of the experiment in the form of a report.

PROGRAM CONTENT		
Lecture		**Number of hours**
Lec1	Electronic amplifiers parameters	2
Lec2-4	BJT, FET, MOSFET transistor amplifier (Q-point/small signal model/ pulse amplifier/wideband amplifier/ power amplifier	6
Lec5-8	Differential amplifier; Operational amplifier and its applications (inverting and non-inverting amplifier / integrator and differentiator / filters / non-linear applications / comparators)	8
Lec9	AD and DA converters.	2
Lec10	Sine wave oscillators and flip-flops.	2
Lec11-13	Power supply circuits; voltage and current regulators; DC-DC converters	6
Lec14	PLL and applications; synchronous detection.	2
Lec15	Summary, overview	2
	Total hours:	30

Laboratory		Number of hours
Lab1	Introduction: - familiarizing students with the rules of work safety in the laboratory; -to familiarize students with the operation of the apparatus	3
Lab2-10	The student performs eight measurement experiments from the list of topics available in the Laboratory of Electronic Systems: 1. Operational amplifier – basic configurations; 2. Operational amplifier – differentiator, integrator 3. Operational amplifier – active filter; 4. Instrumentation amplifier; 5. Transistor amplifier – CE configuration; 6. Transistor as a switch; 7. Rectifier with capacitive filtering; 8. Linear voltage regulator; 9. DC-DC converter – up converter; 10. DC-DC converter – down converter; 11. DC-DC converter – inverter; 12. DC-DC converter – (by WURTH); 13. Power amplifier; 14. Kristal generator (SMD); 15. Astable flip-flop- 555; 16. Monostable flip-flop – 555; 17. Self-constructed DCPM motor; 18. Pressure sensor with microcontroller (advanced); 19. PLL – frequency synthesizer (advanced); 20. Light sources parameters (advanced); 21. LED parameters (advanced); 22. Relay actuator – (electromechanical relay and SSR) –(advanced); 23. Stepper motor medium power (advanced);	27
	Total hours:	30

Project		Number of hours
Pr1-3	Operational amplifier – calculations and computer analysis, adder, differentiator, integrator, active filter, inverter, follower and other application (LTSPICE analysis)	6
Pr4-6	Transistor amplifier – quiescent point, small signal analysis, computer analysis (LTSPICE)	6
Pr7	Voltage regulators (linear and switching) – calculations and computer analysis	2
Pr8-9	Power supply, rectifier - calculations and computer analysis (LTSPICE)	4
Pr10-14	Individual design of a simple electronic circuit (calculations, computer analysis, PCB design, report development)	10
Pr15	summary, repetition	2
	Total hours:	30

TEACHING TOOLS USED
N1. Traditional lecture (chalkboard).
N2. Slide presentation, computer with proper program (eg. PowePoint).
N3. Computer with electronic circuits analysis program (SPICE-like, eg. LTspice)
N4. Design classes in small groups - 12 people (in exceptional cases up to 18 people)

N5. Selfstudy.

N6. Laboratory stations equipped with: laboratory power supply, universal meter, digital oscilloscope, function generator, tools (soldering iron, tweezers, screwdriver, cutters, magnifier), and a set of electronic materials for the exercise (PCB, resistors, capacitors, integrated circuits, etc. .) and specialist equipment depending on the task performed.

N7. Work in pars (in special case 3 persons team)

N8. Consultations.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation: F — forming (during semester), C — concluding (at semester end)	Learning outcome code	Way of evaluating learning outcome achievement
F1	PEU_W01	Finalt est
F2	PEU_U01	Quizzes and/or homework and/or final test
F3	PEU_U02	Quizzes, implementation of the circuit, measurements and a report on the measurements.
P = (F1 + F2 + F3)/3 (in order to pass the course, allF1 , F2 and F3 must be positive)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] W. Tietze, Ch. Schenk, Electronic Circuits. Handbook for Design and Applications, Springer, 2009,

[2] P. Horowitz, W. Hill, The Art. Of Electronics, Cambridge University Press 2015

[3] C. Kitchin, L. Counts, A designer's guide to instrumentation amplifier, 3rd edition, Analog Devices , 2006

SECONDARY LITERATURE:

[1] R. L. Boylestad , L.Nashelsky – Electronic Devices and Circuits Theory, Pearson, Prentice Hall, 2012 11th edition

[2] S. Kuta, Elementy i układy elektroniczne, AGH 2000,

[3] A. Malvino, D.J.Bates – Electronic Principles, McGraw Hill, 2008

[4] M. Rusek, J. Pasierbiński, Elementy i układy elektroniczne w pytaniach i odpowiedziach WNT, 2020.

[5] Materials for classes on the website of the subject

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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Zał. nr 5 do ZW 16/2020

FACULTY OF ELECTRONICS W4

SUBJECT CARD

Name of subject in Polish:	**Praktyka zawodowa**
Name of subject in English:	**Internship**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**optional**
Subject code:	**ECEA16001Q**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)				160	
Number of hours of total student workload (CNPS)				180	
Form of crediting				crediting with grade*	
For group of courses mark (X) final course					
Number of ECTS points				**6**	
including number of ECTS points for practical (P) classes				5	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				1	

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Admission to the course by the placement officer

SUBJECT OBJECTIVES

C1 Confrontation of knowledge acquired during the didactic classes covered by the study plan, with the actual requirements set by employers.

C2 Gaining industrial experience, getting to know the basic technical and technological equipment of the company, including getting to know the specifics of higher technical supervision work.

C3 Getting acquainted with the specificity of the professional environment and shaping specific professional skills related directly to the place where the internship is realized.

C4 Improving the ability to organize your own and team work, effective time management, conscientiousness, responsibility for entrusted tasks.

C5 Professionalisation of professional behavior, observance of rules of professional ethics and respect for technical diversity.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
relating to skills:

PEU_U01 Has the ability of individual and team work.
PEU_U02 Has the ability to use the acquired knowledge to creatively analyze and solve various engineering problems.

relating to social competences:
PEU_K01 Awareness of the responsibility for own work, being open to the exchange of ideas and new challenges.

PROGRAMME CONTENT		
Project		**Number of hours**
Proj 1	Individual tasks for each student depending on the choice of placement	**160**
	Total hours	**160**

TEACHING TOOLS USED
N1. Presentation introducing the company's activities. N2. Consultations. N3. Specialist equipment and software used in the company.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1$_{(P)}$	PEU_U01 PEU_U02 PEU_K01	Individual assessment (2,0 ...5,5) on the basis of a written report abour the internship and requirements contained in the "Rules of Internship" or procedure WEK/P1/2013/2015/2017
$P_{(P)}$	**P =F1**	

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
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Zał. nr 5 do ZW 16/2020

FACULTY OF ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Wirtualizacja i chmury obliczeniowe**
Name of subject in English:	**Virtualization and Cloud Computing**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**optional**
Subject code:	**ECEA00216**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	30		60		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course	X				
Number of ECTS points	**3**				
including number of ECTS points for practical (P) classes	-		2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,5		1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.

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SUBJECT OBJECTIVES

C1 Acqusition of knowledge, supported with theory, about methods, techniques, protocols and tools utilized in Classic and Virtual Data Center and Cloud environment,

C2 Acqusition of skills related to the design of Classic and Virtual Data Center and Cloud infrastructure

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:

PEU_W01 Be able to describe cloud computing, deployment and service models, the cloud computing reference model and key issues in building a cloud computing infrastructure.

PEU_W02 Be able to describe the main components and processes required to build the physical, virtualisation, control and service layers of a cloud infrastructure, service orchestration, business continuity and service management of a cloud infrastructure.

Relating to skills:

PEU_U01 Be able to configure selected infrastructure solutions of a classic and virtualised data centre,

PEU_U02 Be able to configure selected cloud computing solutions,

PEU_U03 Knows how to use business continuity mechanisms.

PROGRAMME CONTENT

Lecture		Number of hours
Lec 1	Introduction to Cloud Computing	2
Lec 2	Building the Cloud Infrastructure	2
Lec 3	Physical Layer	1
Lec 4	Virtual Layer	1
Lec 5	Control Layer	1
Lec 6	Service and Orchestration Layers	2
Lec 7	Business Continuity in Cloud	2
Lec 8	Cloud Security	2
Lec 9	Cloud Service Management	2
	Total hours	**15**

Laboratory		Number of hours
Lab 1	Introduction to laboratory classes. Familiarization with laboratory equipment	2
Lab 2	Classic Data Center – configuration of selected infrastructure elements	6
Lab 3	Virtualized Data Center – configuration of selected infrastructure elements	4
Lab 4	Configuration of selected business continuity mechanisms	4
Lab 5	Cloud computing – configuration of selected infrastructure elements	6
Lab6	Practical task – design and configuration of cloud computing solution for the given requirements..	8
	Total hours	**30**

TEACHING TOOLS USED

N1.Information lectures with use of multimedia presentations
N2. Problem solving lectures with use of multimedia presentations
N3.Preparation of laboratory reports
N4. Consultations
N5. Individual work - preparation for laboratory classes
N6. Individual work - individual study and preparation to pass the course

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 - PEU_W02	Written tests
F2	PEU_U01 - PEU_U03	Laboratory reports
C = 0,5*F1 + 0,5*F2, concluding grade may be passing subject to F1 and F2 are passing		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Cloud computing concepts, technology and architecture by Thomas Erl, Zaigham Mahmood and Ricardo Puttini, The Prentice Hall Service Technology Series from Thomas Erl 2013

[2] Computing Networks From Cluster to Cloud Computing, Pascale Vicat-Blanc, Brice Goglin, Romaric Guillier, Sebastien Soudan, Wiley 2011

[3] Information Storage and Management – Storing, Managing, and Protecting Digital Information in Classic, Virtualized, and Cloud Environments 2nd Edition, John Wiley & Sons, Inc.

SECONDARY LITERATURE:

[1] http://education.emc.com/academicalliance

[2] Computerworld magazine

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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Zał. nr 5 do ZW 16/2020

FACULTY: Electronics

SUBJECT CARD

Name of subject in Polish:	**Filozofia**
Name of subject in English:	**Philosophy**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**FLEA00100**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				
Number of hours of total student workload (CNPS)	60				
Form of crediting	Crediting with grade				
For group of courses mark (X) final course					
Number of ECTS points	**2**				
including number of ECTS points for practical (P) classes					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1				

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.

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SUBJECT OBJECTIVES

C1 To acquaint students with specificity of philosophical reflection.
C2 Systematize and deepen the knowledge of the basic methods of inference that regulate and organize our knowledge.
C3 Performance considerations of engineer's activity and to present the issue of social responsibility in science and technology.

SUBJECT EDUCATIONAL EFFECTS	
Relating to knowledge:	
PEU_W01	The student gains knowledge of the basic methods of inference (deduction, induction and abduction).
PEU_W02	The student has knowledge that is essential to understanding and interpreting social and philosophical considerations of engineer's activity.

PROGRAMME CONTENT		
Form of classes – lecture		**Number of hours**
Lec1	The main issues and trends of philosophy	2
Lec2	The similarities and differences between philosophy and religion	2
Lec3	The similarities and differences between philosophy and science	2
Lec4	The basic assumptions of epistemology	2
Lec5	The basic assumptions of ontology	2
Lec6	The basic assumptions of ethics	2
Lec7,8	The overview of contemporary philosophical thought	4
Lec9,10	The basic principles of social philosophy	4
Lec11,12	The basic principles of the philosophy of science and technology	4
Lec13,14	The problem of social responsibility of science and technology	4
Lec15	The social and philosophical considerations of engineer's activity.	2
	Total hours	**30**

TEACHING TOOLS USED
N1. Multimedia presentation. N2. Lecture. N3. Interactive lecture

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01- PEU_W02	Passing test, active participation in lectures
P = F1		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] S. Blackburn, *Oksfordzki słownik filozoficzny*, Warszawa 2004;
[2] T. Buksiński, *Publiczne sfery i religie*, Poznań 2011
[3] A. Chalmers, *Czym jest to, co zwiemy nauką*, Wrocław 1997;
[4] R. M. Chisholm, *Teoria poznania*,1994;
[5] Ch. Frankfort- Nachmiast, D. Nachmiast, *Metody badawcze w naukach społecznych*, Poznań 2001;
[6] A. Grobler, *Metodologia nauk*, Kraków 2004;
[7] M. Heidegger, *Budować mieszkać myśleć*, Warszawa 1977;
[8] M. Heller, *Filozofia przyrody*, Kraków 2005;
[9] T.Kuhn, *Dwa bieguny*, Warszawa, 1895;
[10] B. Latour, *Polityka natury*, Warszawa 2009;
[11] E. Martens, H. Schnädelbach, Filozofia. Podstawowe pytania, Warszawa 1995;
[12] K.R. Popper, *Wiedza obiektywna*, Warszawa 1992;
[13] J. Woleński, *Epistemologia*, Warszawa 2005;
[14] M. Tempczyk, Ontologia świata przyrody, Kraków 2005.

SECONDARY LITERATURE:

[1] A. Anzenbacher, *Wprowadzenie do filozofii*, Kraków 2000;
[2] R. Goodin, P. Pettit, *Przewodnik po współczesnej filozofii politycznej*
[3] B. Depré, *50 teorii filozofii, które powinieneś znać*, Warszawa 2008

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Matematyka – Analiza 1**
Name of subject in English:	**Math – Analysis 1**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**university - wide**
Subject code:	**MAT001653**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	30			
Number of hours of total student workload (CNPS)	120	90			
Form of crediting	Examination	crediting with grade			
For group of courses mark (X) final course	x				
Number of ECTS points	**8**				
including number of ECTS points for practical (P) classes		3			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1	1			

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Recommended knowledge of mathematics equivalent to graduating from high school at the advanced level.

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SUBJECT OBJECTIVES

C1. Understanding the basic concepts and the differential and integral calculus of functions of one variable, and acquire the skills to use them to study the waveform functions and engineering calculations.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge: Student..

PEU_W01 knows the properties of the function; knows the methods of determining boundaries and asymptotes functions; familiar with the concept of continuity and discontinuity points classification;

PEU_W02 knows the basics of differential calculus of functions

PEU_W03 has a basic knowledge of indefinite integral, knows the structure of the definite integral and its properties, he knows the concept of the improper integral

relating to skills: Student..

PEU_U01 is able to calculate limits of sequences and functions, set asymptote functions, use L'Hospital theorem to the indeterminate forms, check the continuity of functions

PEU_U02 can calculate the derivatives and interpret the results, can make use of the differential in the estimate calculus, can examine the property and conduct functions of one variable

PEU_U03 can determine the indefinite integral of elementary functions and rational functions, can calculate and interpret the definite integral, is able to solve engineering problems using integrals

relating to social competences:

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1,2	Series and Basic criteria of convergence. Limit of a function at a point (proper and improper). The left- and right-hand limits. The technique of calculating the limits. Limits of basic indeterminate forms.	4
Lec 3	Continuity of a function at point and on an interval. One-sided continuity functions. Discontinuity points and their types. Theorems on continuous functions on a closed interval and their applications. Approximate solving equations	2
Lec 4,5	The derivative of a function at a point. One-sided and improper derivatives. Derivatives of basic elementary functions. Differentiation. Derivatives of higher orders. Geometric and physical interpretation of the derivative. Tangent.	4
Lec 6,7	Differentials and its application to approximate calculations. Mean value theorems (Rolle`a, Lagrange). Examples of applications of the Lagrange theorem. Taylor and Maclaurin formulas and their applications. L'Hôpital's rule.	4
Lec 8,9	Intervals of monotonicity of a function. Local extrema of the functions. Necessary and sufficient conditions of existence for local extremes. Convex and concave functions and points of inflection. Examination of a function.	4
10	Indefinite integrals and basic properties. Integration by parts. Integration by substitution.	2
11,12	Integration of rational and trigonometric functions.	4
13,14	The definition of definite integral. Geometric and physical interpretation. Properties of the definite integral. The average value of the function on the interval. Newton - Leibniz theorem. Integration by parts and by substitution.	4
15	Improper integral of type 1. The comparative criterion and quotient convergence. Applications of integrals in geometry (area, arc length, volume	2

	of the rotary body, surface area of the solid of revolution) and technology.	
	Total	**30**
Classes		**Number of hours**
Cl 1,2	Series and Basic criteria of convergence. Limit of a function at a point (proper and improper). One-sided limits. The technique of calculating the limits. Limits of basic unmarked forms.	4
Cl 3	Continuity of a function at point and on a segment. Discontinuity points and their types. Theorems on continuous functions on a closed segment and their applications. Approximate solving equations.	2
Cl 4,5	The derivative of the function at the point. One-side and improper derivatives. Derivatives of basic elementary functions. Differentiation. Derivatives of higher orders. Geometric and physical interpretation of the derivative. Tangent.	4
Cl 6,7	Differentials and its application to approximate calculations. Mean value theorems (Rolle`a, Lagrange). Examples of applications of the Lagrange theorem. Taylor and Maclaurin formulas and their applications. L'Hôpital's rule.	2
Cl 7,8	Segments of monotonicity of a function. Local extremes of the functions. Necessary and sufficient conditions of existence of local extremes. Convex and concave functions and points of inflection. Examination of a function.	4
Cl 9	Indefinite integrals and basic properties. Integration by parts. Integration by substitution.	2
Cl 10,11	Integration of rational and trigonometric functions.	4
Cl 12,13	The definition of definite integral. Geometric and physical interpretation. Properties of the definite integral. The average value of the function on the segment. Newton - Leibniz theorem. Integration by parts and by substitution.	4
Cl 14	Improper integral of the first kind. The comparative criterion and quotient convergence. Applications of integrals in geometry (area, arc length, volume of the rotary body, surface area of the solid of revolution) and technology.	2
Cl 15	Sumary	2
	TOTAL	**30**

TEACHING TOOLS USED
N1.Chalkboard N2.Consultations N3. Self-education

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 – PEU_W02	Written exam
F2	PEU_U01 – PEU_U03	Test
P = P = (0.51*F1+0.49*F2); F1 and F2 must be positive		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] F. Ayres, E. Mendelson: Calculus, 6th edition, McGraw Hill.
[2] R. Adams, C. Essex, Calculus: a complete course, Pearson, 2013.
[3] R. Wrede, M.Spiegel, Advanced Calculus, 3rd edition, McGraw Hill.

SECONDARY LITERATURE:

[4] G. M. Fichtenholz, Rachunek różniczkowy i całkowy, T. I-II, PWN, Warszawa 2007.
[5] M. Gewert, Z. Skoczylas, Analiza matematyczna 1. Definicje, twierdzenia, wzory, Oficyna Wydawnicza GiS, Wrocław 2002.
[6] M. Gewert, Z. Skoczylas, Analiza matematyczna 2. Definicje, twierdzenia, wzory, Oficyna Wydawnicza GiS, Wrocław 2005.
[7] R. Leitner, Zarys

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Zał. nr 5 do ZW 16/2020

FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Matematyka – Algebra**
Name of subject in English:	**Math – Algebra**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**university - wide**
Subject code:	**MAT001654**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	30			
Number of hours of total student workload (CNPS)	120	90			
Form of crediting	Examination	crediting with grade			
For group of courses mark (X) final course	x				
Number of ECTS points	**8**				
including number of ECTS points for practical (P) classes		3			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1	1			

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Recommended knowledge of mathematics equivalent to graduating from high school at the advanced level

SUBJECT OBJECTIVES

C1. Opanowanie podstawowej wiedzy i umiejętności w zakresie logiki matematycznej i teorii mnogości

C2. Opanowanie podstawowej wiedzy i umiejętności z geometrii analitycznej w przestrzeni.

C3. Opanowanie podstawowej wiedzy i umiejętności w zakresie liczb zespolonych.

C4. Poznanie podstawowych pojęć rachunku macierzowego z zastosowaniem do rozwiązywania układów równań liniowych.

C5. Opanowanie podstawowej wiedzy i umiejętności w zakresie wielomianów i funkcji wymiernych

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge: Student..

PEU_W01 has a basic knowledge of mathematical logic and set theory

PEU_W02 has a basic knowledge of analytic geometry on a plane and in space,

PEU_W03 knows the properties of complex numbers

PEU_W04 has a basic knowledge of linear algebra, knows matrix methods of solving of linear equations systems

PEU_W05 has knowledge of polynomial and rational functions, knows the basic theorem of algebra

relating to skills: Student

PEU_W01 able to use the knowledge of mathematical logic and set theory

PEU_U02 able to determine the equation of surfaces and line in space and use vector calculus in the geometrical construction

PEU_U03 can perform calculations using various forms of complex numbers

PEU_U04 can use the matrix calculus, calculate determinants and solve systems of linear equations using linear algebra methods

PEU_U05 can decompose polynomial and rational function into partial fractions

relating to social competences:

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PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1-3	INTRODUCTION TO MATHEMATICS. Mathematical logic and set theory	6
Lec 4,5	ANALYTICAL GEOMETRY ON A PLANE. Vectors on the plane. Operations on vectors. Dot product. Orthogonality. Equations of the line (in traditional, directional, parametric forms). Terms of parallel and perpendicular lines. Distance from a point to a line. Parabola, ellipse, hyperbole	4
Lec 6	ANALYTICAL GEOMETRY IN SPACE. Cartesian coordinate system. Adding vectors and vector multiplication by a number. The length of the vector. Dot product. The angle between the vectors. Three vectors in space. Cross product. Area and volume calculations using vectors. Non-Cartesian coordinate systems	2
Lec 7,8	COMPLEX NUMBERS. Operations, exponential and trigonometric forms.	4
Lec 9	MATRICES. The definition of a matrix. Matrix multiplication by a number. Matrix operations. Properties of matrix operations. Transposing a matrix. The types of matrix (unit, diagonal, symmetric, etc.).	2
Lec 10,11	DETERMINANTS. Definition of determinant - Laplace expansion. Determinant of transposed matrix. Elementary transformations of determinant. Cauchy theorem Inverse matrix.	4
Lec 12,13	SYSTEMS OF LINEAR EQUATIONS. The system of linear equations. Cramer's rule. Homogenous system. Solving of arbitrary systems of linear equations. Gauss elimination - transformation of a matrix to upper triangular. Solving the system with triangular matrix.	4

	Plane. General and parametric equation. Normal vector to the plane. The angle between the planes. The mutual position of the surfaces. Line in space. Line as intersection of two planes. Parametric equation of a line. The direction vector. The point of intersection of the plane and line. Skew lines. Distance of a point to a plane and line.	
Lec 14,15	POLYNOMIALS. Operations on polynomials. Polynomial root. Bezout theorem. The fundamental theorem of algebra. Linear and quadratic factors of Polynomial. Rational function. Real simple fractions. Decomposition of rational function into partial fractions.	4
	TOTAL	**30**
Classes		**Number of hours**
Cl 1	INTRODUCTION TO MATHEMATICS. Mathematical logic and set theory	4
Cl 2	ANALYTICAL GEOMETRY ON A PLANE. Vectors on the plane. Operations on vectors. Dot product. Orthogonality. Equations of the line (in traditional, directional, parametric forms). Terms of parallel and perpendicular lines. Distance from a point to a line. Parabola, ellipse, hyperbole	2
Cl 3	ANALYTICAL GEOMETRY IN SPACE. Cartesian coordinate system. Adding vectors and vector multiplication by a number. The length of the vector. Dot product. The angle between the vectors. Three vectors in space. Cross product. Area and volume calculations using vectors. Non-Cartesian coordinate systems	2
Cl 4	COMPLEX NUMBERS. Operations, exponential and trigonometric forms.	4
..	MATRICES. The definition of a matrix. Matrix multiplication by a number. Matrix operations. Properties of matrix operations. Transposing a matrix. The types of matrix (unit, diagonal, symmetric, etc.).	4
	DETERMINANTS. Definition of determinant - Laplace expansion. Determinant of transposed matrix. Elementary transformations of determinant. Cauchy theorem Inverse matrix.	4
	SYSTEMS OF LINEAR EQUATIONS. The system of linear equations. Cramer's rule. Homogenous system. Solving of arbitrary systems of linear equations. Gauss elimination - transformation of a matrix to upper triangular. Solving the system with triangular matrix. Plane. General and parametric equation. Normal vector to the plane. The angle between the planes. The mutual position of the surfaces. Line in space. Line as intersection of two planes. Parametric equation of a line. The direction vector. The point of intersection of the plane and line. Skew lines. Distance of a point to a plane and line.	4
	POLYNOMIALS. Operations on polynomials. Polynomial root. Bezout theorem. The fundamental theorem of algebra. Linear and quadratic factors of Polynomial. Rational function. Real simple fractions. Decomposition of rational function	4

	into partial fractions.	
	Resume	2
	TOTAL	**30**

TEACHING TOOLS USED

N1.Chalkboard
N2.Consultations
N3. Self-education

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 – PEU_W04	Writen exam
F2	PEU_U01 - PEU_U04	Test
P = P = (0.51*F1+0.49*F2); F1 i F2 must be positive		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] S. Lipschutz, M. Lipson, Linear Algebra, McGraw Hill, 5th edition
[2] Robert A. Beezer, A First Course in Linear Algebra
[3] M. Spiegel, S. Lipschutz, Vector Analysis, McGraw Hill
[4] M. Spiegel, S. Lipschutz, Complex Variables, McGraw Hill

SECONDARY LITERATURE:

[5] T. Huskowski, H. Korczowski, H. Matuszczyk, Algebra liniowa, Wydawnictwo Politechniki Wrocławskiej, Wrocław 1980.
[6] T. Jurlewicz, Z. Skoczylas, Algebra i geometria analityczna. Przykłady i zadania, Oficyna Wydawnicza GiS, Wrocław 2011.
[7] T. Jurlewicz, Z. Skoczylas, Algebra liniowa. Przykłady i zadania, Oficyna Wydawnicza GiS, Wrocław 2005.
[8] J. Klukowski, I. Nabiałek, Algebra dla studentów, WNT, Warszawa 2005.
[9] W. Stankiewicz, Zadania z matematyki dla wyższych uczelni technicznych, Cz. A, PWN, Warszawa 2003.
[10] .T. Trajdos, Matematyka, Cz. III, WNT, Warszawa 2005
[11] G. Banaszak, W. Gajda, Elementy algebry liniowej, część I, WNT, Warszawa 2002
[12] B. Gleichgewicht, Algebra, Oficyna Wydawnicza GiS, Wrocław 2004.
[13] T. Jurlewicz, Z. Skoczylas, Algebra i geometria analityczna.. Definicje, twierdzenia i wzory. Oficyna Wydawnicza GiS, Wrocław 2011.
[14] T. Jurlewicz, Z. Skoczylas, Algebra liniowa. Definicje, twierdzenia i wzory. Oficyna Wydawnicza GiS, Wrocław 2005.
[15] E. Kącki, D.Sadowska, L. Siewierski, Geometria analityczna w zadaniach, PWN, Warszawa 1993
[16] F. Leja, Geometria analityczna, PWN, Warszawa 1972

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Fizyka**
Name of subject in English:	**Physics**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**FZP001127**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	90		90		
Form of crediting	Examination		crediting with grade		
For group of courses mark (X) final course	x				
Number of ECTS points	**6**				
including number of ECTS points for practical (P) classes			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1		1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Recommended knowledge of physics on the extended level of Polish Matura

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SUBJECT OBJECTIVES

C1. Acquire basic knowledge of classical mechanics, phenomenological thermodynamics, concepts of statistical thermodynamics, quantum physics and condensed matter physics.

C2.Master the skill of conducting a simple experiment, estimating the uncertainty of measurement results and preparing a report on experiment.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 – knows and can explain basic laws of point mass dynamics, point mass systems and a rigid body; knows properties of an oscillator and wave phenomena. .

PEU_W02 – knows and can explain basic laws phenomenological thermodynamics and understands basic concepts of statistical thermodynamics (classical and quantum statistics)

PEU_W03 – knows basic concepts of quantum mechanics and quantum optics; knows properties of real quantum systems (atom, molecule, crystal, nanostructures)

relating to skills:

PEU_U01 – can use simple measuring devices (for measuring length, time and other physical quantities)

PEU_U02 – can perform the measurement of basic physical quantities with the use of the measuring system instruction

PEU_U03 – can work out the measurement results and do the uncertainty analysis with the use of engineering tools

relating to social competences:

PEU_K01 can collaborate in a small group

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Introduction: the subject of interest and methodology of physics; scientific method; physical quantities and units	2
Lec 2	Kinematics – mathematical description of motion	2
Lec 3	Point mass dynamics; equations of motion for simple cases	2
Lec 4	Work and mechanical energy; mechanical energy conservation principle	2
Lec 5	Dynamics of point mass systems; momentum conservation principle	2
Lec 6	Dynamics of circular motion; rigid body; angular momentum conservation principle	2
Lec 7	Oscillatory motion; harmonic oscillator; damped and forced oscillations; resonance	2
Lec 8	Elements of wave physics; definition of a wave; energy and momentum transport; interference phenomena; standing waves; electromagnetic spectrum	2
Lec 9	Black body radiation; quantum statistics. External photoelectric effect; wave-particle duality of light	2
Lec 10	Line spectra - the puzzle of the atom structure. De Broglie hypothesis; Davisson-Germer experiment; electron diffraction on a double slit.	2
Lec 11	Basics of quantum mechanics: Born probabilistic interpretation; Schrödinger equation; measurement in quantum mechanics; Heisenberg uncertainty principle; quantum entanglement	2
Lec 12-13	Simple model quantum systems: 1D potential well, well systems; reference to real systems (atom, systems of atoms). Ground and excited states. Laser.	4

Lec14-15	Properties of metals and dielectrics in quantum picture (electronic band structure). Semiconductors – basic properties. Elements of p-n junction physics; semiconductor devices: diode, transistor, light emitting diode, semiconductor laser, EM radiation detector.	4
	Total hours	**30**

Laboratory		**Number of hours**
Lab 1	Introduction to laboratory classses: organizational issues and rules of work in the lab; getting familiar with: a) health and safety rules, b) rules of preparing written reports on exercises, c) getting familiar with basics of measurement uncertainty analysis. Examples of simple measurements.	2
Lab 2	Determination of the moment of inertia for chosen rigid bodies with the use of the physical pendulum method; checking the Steiner theorem	2
Lab 3	Determination of thermal expansion coefficient with the use of electrical method	2
Lab 4	Measurement of thermal conductivity of insulators	2
Lab 5	Measurements of resistivity dependence on temperature in metals and semiconductors	2
Lab 6	Investigation into the Ohm law for alternated current (AC)	2
Lab 7	Investigation into electromagnetic resonance	2
Lab 8	Measurement of the focal lengths of thin lenses	2
Lab 9	Determination of the wavelength with the use of diffraction grating	2
Lab 10	Determination of the lens curvature radius and the wavelength with the use of Newton rings	2
Lab 11	Determination of the Planc constant basing on the characteristics of electroluminescent diodes	2
Lab 12	Investigation into the Hall effect	2
Lab 13	Supplementary classes and crediting	6
Total		**30**

TEACHING TOOLS USED

N1.Traditional lecture.
N2.Consultations
N3. Self-study
N4. Laboratory exercises

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 – PEU_W03	Written or oral exam
F2	PEU_U01 – PEU_U03 PEU_K01	Tests and/or oral answers, reports
C= (0.51*F1+0.49*F2); F1 i F2 must be positive		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] H. D. Young, R. A. Freedman, *University Physics,* Pearson–Addison Wesley, 2014
[2] Hyperphysics: http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html
[3] Source books in English available in the library
[4] Ćwiczenia Laboratoryjne z Fizyki, Tomy 1-4, Oficyna Wydawnicza Politechniki Wrocławskiej (available on the web page http://www.if.pwr.wroc.pl/lpf)
[5] Descriptions of experiments and working instructions available on the web page http://www.if.pwr.wroc.pl/

SECONDARY LITERATURE:

[6] D. Halliday, R. Resnick, J. Walker, Podstawy fizyki, tom 1,2,4,5, Wydawnictwo Naukowe PWN, Warszawa 2003
[7] Jay Orear, Fizyka, Wydawnictwo Naukowo-Techniczne, Warszawa, 2008.
[8] I.W. Sawieliew, Wykłady z fizyki, tom 1-3, Wydawnictwo Naukowe PWN, Warszawa, 2003.
[9] List of problems published by the lecturer,
[10] W. Korczak, M. Trajdos, *Wektory, pochodne, całki*, Wydawnictwo Naukowe PWN, Warszawa, 2013.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Dr inż. Paweł Scharoch, pawel.scharoch@pwr.edu.pl

FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Matematyka dla elektroników**
Name of subject in English:	**Math for Electronics**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**MAT001512**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	30			
Number of hours of total student workload (CNPS)	60	60			
Form of crediting	crediting with grade	crediting with grade			
For group of courses mark (X) final course	x				
Number of ECTS points	**4**				
including number of ECTS points for practical (P) classes		2			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1	1			

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Recommended knowledge of differential and integral calculus of one variable and basic concepts of algebra.

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SUBJECT OBJECTIVES

C1 Learning the basic concepts and methods of calculus of probability - Learning classical probabilistic distributions, their properties and applications to practical problems in various fields of science and technology

C2 to know the basic concepts and methods of calculus of mathematical statistics in practical issues in different fields of engineering applications

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge: Student…

PEU_W01 knows the basic concepts and methods of calculus of probability and how to apply basic methods of calculus of probability to solve theoretical and practical problems in various fields of science and technology

PEU_W02 have knowledge of the tasks of statistical hypothesis testing and basic tests on parameters of distributions and selected non-parametric tests

relating to skills: Student..

PEU_U01 is able to apply basic methods of calculus of probability to solve theoretical and practical problems in engineering applications,

PEU_U02 can select and apply basic statistical tests and can apply and select estimation methods for simple statistical models in engineering applications

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relating to social competences:

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PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1,2	The space of elementary events. Events, operations on events. Axiomatic definition of probability. Properties of probability. The classical and geometric probability. Variations, permutations, combinations..	4
Lec 3	The definition of conditional probability. The formula for the total probability. Bayes' formula. Independence of events ..	2
Lec 4	Definition of random variable. Examples. Distribution of random variable. Cumulative distribution and its properties. Classification of random variables. Distributions of functions of random variables ...	2
Lec 5,6	Discrete random variables. Overview of discrete distributions: two-point, binomial, Poisson. Poisson approximation to the binomial distribution. Continuous random variables. Probability density function and its relationship with the cumulative distribution function. Overview of continuous distributions: uniform, normal, exponential.	4
Lec 7	The parameters of random variables. The expected value and its properties. Moments of higher orders. The variance and its properties. Quantiles. Expected values, variances, medians and quantiles of selected distributions. Standardization of a random variable with a normal distribution. Normal distribution tables.	2
Lec 8	Two-dimensional random variables. The definition of the bivariate cumulative distribution and density. Marginal distributions. Independence of random variables. Moments, the correlation coefficient. Sequences of random variables: sum of independent random variables, expected value and variance	2

	of such a sum. The weak law of large numbers.	
Lec 9	The definition of convergence in distribution. Central limit theorem, Moivre`a – Laplace's theorem, Lindeberg-Levy's theorem,.	2
Lec 10	Basic concepts of statistics, the concept of statistical test, tests of significance, errors of the 1st and 2nd kind (false positive and false negative), examples of simple hypothesis tests	2
Lec 11	Tests for the mean, test for the correlation coefficient, selected non-parametric tests – chi-squared tests, examples of *selection* tests and their applications	2
Lec 12	Elements of the theory of parametric estimation - requirements for estimator ((asymptotic) unbiasedness, consistency, variance of an estimator and Cramer-Rao inequality)	2
Lec 13	Classical methods of constructing estimators (methods of: moments and maximum likelihood) with application examples	2
Lec 14	Introduction to the estimation of linear regression	2
Lec 15	Summary	2
	Total hours	**30**

Classes		**Number of hours**
Cl 1,2	The space of elementary events. Events, operations on events. Axiomatic definition of probability. Properties of probability. The classical and geometric probability. Variations, permutations, combinations..	4
Cl 3	The definition of conditional probability. The formula for the total probability. Bayes' formula. Independence of events ..	2
Cl 4	Definition of random variable. Examples. Distribution of random variable. Cumulative distribution and its properties. Classification of random variables. Distributions of functions of random variables ...	2
Cl 5,6	Discrete random variables. Overview of discrete distributions: two-point, binomial, Poisson. Poisson approximation to the binomial distribution. Random variables of the continuous type. Density of probability Density and its relationship with the cumulative distribution function. Overview of continuous distributions: uniform, normal, exponential.	4
Cl 7	The parameters of random variables. The expected value and its properties. Moments of higher orders. The variance and its properties. Quantile of order p. Expected values, variances, medians and quantiles of selected distributions. Standardization of a random variable with a normal distribution. Normal distribution tables.	2
Cl 8	Two-dimensional random variables. The definition of the cumulative distribution and density. Marginal distributions. Independence of random variables. Moments, the correlation coefficient. Sequences of random	2

	variables: the summation of independent random variables, expected value and variance of such a sum. The law of large numbers (weak).	
Cl 9	The definition of convergence in distribution. Central limit theorem, Lindeberg-Levy's theorem, Moivre`a – Laplace's theorem.	2
Cl 10	Basic concepts of statistics, the concept statistical test, tests of significance, errors of 1st and 2nd kind (false positive and false negative), examples of simple hypothesis tests	2
Cl 11	Tests for the expected value, test for correlation coefficient, selected non-parametric tests – chi-squared tests, examples of selection tests and their applications	2
Cl 12	Elements of the theory of parameter estimation - requirements for estimator ((asymptotic) unbiasedness, consistency, variance of an estimator and Cramer-Rao inequality)	**2**
Cl 13	Classical methods of constructing estimators (methods of: moments and maximum likelihood) with application examples	**2**
Cl 14	Introduction to the estimation of linear regression	**2**
Cl 15	Summary	**2**
	Total hours	**30**

TEACHING TOOLS USED
N1.Chalkboard N2. Consultations N3. Self-education N4. Computer with program for statistics (STATISTICA, MATLAB or, at least EXEL)

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 – PEU_W02	Test
F2	PEU_U01 –PEU_U02	Test
P = P = (0.51*F1+0.49*F2); F1 and F2 must be positive		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] [Douglas C. Montgomery, Applied Statistics and Probability for Engineers Third Edition

SECONDARY LITERATURE:

[2] J. Jakubowski, R. Sztencel, Rachunek prawdopodobieństwa dla prawie każdego, Script, Warszawa 2002.

[3] A. Papoulis, Prawdopodobieństwo, zmienne losowe i procesy stochastyczne, WNT, Warszawa 1972.

[4] H. Jasiulewicz, W. Kordecki, Rachunek prawdopodobieństwa i statystyka matematyczna. Przykłady i zadania, Oficyna Wydawnicza GiS, Wrocław 2001.

[5] A. Plucińska, E. Pluciński, Probabilistyka, WNT, Warszawa 2006.

[6] W. Krysicki, J. Bartos, W. Dyczka, K. Królikowska, M. Wasilewski, Rachunek prawdopodobieństwa i statystyka matematyczna w zadaniach, Cz. I-II, PWN, Warszawa 2007.

[7] PRD. Bobrowski, Probabilistyka w zastosowaniach technicznych, PWN, Warszawa 1986.

[8] A. A. Borowkow, Rachunek prawdopodobieństwa, PWN, Warszawa 1975.

[9] W. Feller, Wstęp do rachunku prawdopodobieństwa, T. I, PWN, Warszawa 2006.

[10] M. Fisz, Rachunek prawdopodobieństwa i statystyka matematyczna, PWN, Warszawa 1967.

[11] T. Inglot, T. Ledwina, Z. Ławniczak, Materiały do ćwiczeń z rachunku prawdopodobieństwa i statystyki matematycznej, Wydawnictwo Politechniki Wrocławskiej, Wrocław 1984.

[12] J. Jakubowski, R. Sztencel, Wstęp do teorii prawdopodobieństwa, Script, Warszawa 2001.

[13] W. Kordecki, Rachunek prawdopodobieństwa i statystyka matematyczna. Definicje, twierdzenia, wzory, Oficyna Wydawnicza GiS, Wrocław 2002.

[14] Koronacki J., Mielniczuk J., Statystyka dla kierunków technicznych i przyrodniczych. WNT,Warszawa, 2001.

[15] Gajek, Kałuszka, “Wnioskowanie statystyczne”, WNT, Warszawa, 2000

[16] Wybrane rozdziały z podreczników prof. Magiery i prof. Krzysko (beda wskazane na wykładzie)

[17] Kordecki W., Rachunek prawdopodobienstwa Oficyna Wydawnicza PWr, Wrocław 2003.

[18] Krysicki W. i inni, Rachunek prawdopodobienstwa i statystyka matematyczna w zadaniach,Czesc I i II, PWN, Warszawa, 1996.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Jerzy. Witkowski, jerzy.witkowski@pwr.edu.pl

Zał. nr 5 do ZW 16/2020

FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Matematyka – Analiza 2**
Name of subject in English:	**Math – Analysis 2**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**university - wide**
Subject code:	**MAT001510**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	30			
Number of hours of total student workload (CNPS)	60	90			
Form of crediting	crediting with grade	crediting with grade			
For group of courses mark (X) final course	**x**				
Number of ECTS points	**5**				
including number of ECTS points for practical (P) classes		3			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1	1			

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Differential and integral calculus of one variable.
Basic concepts of algebra.

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SUBJECT OBJECTIVES

C1. Understanding the basic properties of ordinary differential equations and methods of solving them.
C2 Understanding the basic properties of differential equations.
C3. Understanding the basic concepts of functions of several variables (including multiple integrals and differential operators).

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge: student..

PEU_W01 knows the basic concepts of differential and difference equations and basic methods of solving them

PEU_W02 knows the definitions and basic properties of curvilinear and surface integrals, and their applications

PEU_W03 knows the basic differential operators for scalar and vector

relating to skills: Student..

PEU_W01 is able to derive and solve simple differential equation by different methods

PEU_U02 can calculate line and surface integrals, oriented and non-oriented and knows how to apply them in engineering problems

PEU_U03 knows how to apply differential operators for scalar sand vectors in engineering calculus

relating to social competences:

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1,2	Systems of linear ordinary differential equations of the first order - the theorem on the existence, uniqueness and extending solutions. Basic methods of solving of differential equations.	4
Lec 3	Stability and asymptotic stability of equilibrium points of autonomous systems of ordinary differential equations of the first order - testing by the eigenvalues of matrix system, linearization method, the use of Lyapunov's functions.	2
Lec 4,5	Linear ordinary differential equations of higher orders - the characteristic polynomial, the method of undetermined coefficients and variation of parameters.	4
Lec 6,7	Laplace transform; application for solving differential equations	4
Lec 8	Fundamentals of difference calculus - the introduction; the general solution of difference equations; initial issue for the difference equation and the particular solution of difference equations. Linear difference equations of the first order – forms of solutions for general and special cases when some coefficients are constant.	2
Lec 9,10,11	Homogeneous linear difference equations of higher orders with constant coefficients - the characteristic polynomial and form a solution. Inhomogeneous linear difference equations of higher orders - the method of undetermined coefficients. Z-transform -application for solving difference equations	6
Lec 12	Partial derivatives of first order. Definition. Geometric interpretation. The plane tangent to the function of two variables. Exact differential	2
Lec 13,14	Directional derivatives. Gradient of a function. Higher order partial derivatives. Local extremes of functions of two variables. Elements of field theory. Differential operators for scalar and vector. Gauss and Stokes theorems. Examples of applications of curvilinear and surface integrals.	4

	The definition of line surface and volume integrals;. Geometric interpretation. Examples of calculations of integrals.	
Lec 15	Partial Differential Equations - examples of applications	2
	TOTAL	30

Classes		**Number of hours**
Cl 1	Systems of linear ordinary differential equations of the first order - the claim about the existence, uniqueness and extending solutions. Basic methods of solving of differential equations.	2
Cl 2	Stability and asymptotic stability of equilibrium points of autonomous systems of ordinary differential equations of the first order - testing by the eigenvalues of matrix system, linearization method, the use of Lyapunov's functions.	2
Cl 3	Linear ordinary differential equations of higher orders - the characteristic polynomial, the method of undetermined coefficients and variation of parameters.	2
Cl 4,5,6	Laplace transform; application for solving differential equations	6
Cl 7	Fundamentals of difference calculus - the introduction; the general solution of difference equations; initial issue for the difference equation and the particular solution of difference equations. Linear difference equations of the first order – forms of solutions for general and special cases when some coefficients are constant.	2
Cl 8,9,10	Homogeneous linear difference equations of higher orders with constant coefficients - the characteristic polynomial and form a solution. Inhomogeneous linear difference equations of higher orders - the method of undetermined coefficients. Z-transform -application for solving difference equations	6
Cl 11,12	Partial derivatives of first order. Definition. Geometric interpretation. The plane tangent to the function of two variables. Exact differential	4
Cl 13	Directional derivatives. Gradient of a function. Higher order partial derivatives. Local extremes of functions of two variables. Elements of field theory. Differential operators for scalar and vector. Gauss and Stokes theorems. Examples of applications of curvilinear and surface integrals. The definition of line surface and volume integrals;. Geometric interpretation. Examples of calculations of integrals.	2
Cl 14	Partial Differential Equations - examples of applications	2
Cl 15	Summary	2
	TOTAL	30

TEACHING TOOLS USED
N1.Chalkboard N2. Consultations N3. Self-education

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating achievement
F1	PEU_W01 – PEU_W03	Writen exam
F2	PEU_U01 – PEU_U03	Test
P = P = (0.51*F1+0.49*F2); F1 and F2 must be positive		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] [1] M. Spiegel, S. Lipschutz…., Complex Variables, 2nd edition, McGraw Hill
[2] R. Bronson, Differential Equations, 4th edition, McGraw Hill
[3] P.DuChateau, D. Zachmann, Partial Differential Equations, McGraw Hill
[4] S. Elaydi, An Introduction to Difference Equations, Springer

SECONDARY LITERATURE:

[5] [F. Leja, Rachunek różniczkowy i całkowy ze wstępem do równań różniczkowych, PWN, Warszawa 2008.
[6] W. Krysicki, L. Włodarski, Analiza matematyczna w zadaniach, Cz. II, PWN, Warszawa 2006.
[7] W. Żakowski, W. Kołodziej, Matematyka, Cz. II, WNT, Warszawa 2003.
[8] W. Żakowski, W. Leksiński, Matematyka, Cz. IV. WNT, Warszawa 2002.
[9] M. Gewert, Z. Skoczylas, Analiza matematyczna 2. Przykłady i zadania, Oficyna Wydawnicza GiS, Wrocław 2005.
[10] M. Gewert, Z.Skoczylas, Analiza matematyczna 2. Definicje, twierdzenia, wzory, Oficyna Wydawnicza GiS, Wrocław 2005.
[11] M. Gewert, Z. Skoczylas, Elementy analizy wektorowej. Teoria, przykłady, zadania, Oficyna Wydawnicza GiS, Wrocław 2005.
[12] M. Fichtenholz, Rachunek różniczkowy i całkowy, T. II-III, PWN, Warszawa 2007.
[13] W. Stankiewicz, Zadania z matematyki dla wyższych uczelni technicznych, Cz. B, PWN, Warszawa 2003

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Jerzy Witkowski, jerzy.witkowski@pwr.edu.pl

Zał. nr 5 do ZW 16/2020

FACULTY OF ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Przedsiębiorczość**
Name of subject in English:	**Entrepreneurship**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**optional**
Subject code:	**ZMZ001048**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				
Number of hours of total student workload (CNPS)	30				
Form of crediting	crediting with grade				
For group of courses mark (X) final course					
Number of ECTS points	**1**				
including number of ECTS points for practical (P) classes					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,0				

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

C1. Providing knowledge about Entrepreneurship and Quality management

C2. Obtaining by students skills - for adopting modern method of support entrepreneurship, innovations and quality management.

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:
PEU_W01 Student knows the idea of Entrepreneurship and Quality Management
PEU_W02 Student knows types of entrepreneurship and Quality Management
PEU_W03 Student achieves knowledge about method and instruments for support Entrepreneurship, Innovations and Quality

Relating to skills:
PEU_U01 Student is ready to adopt method and instruments for support Entrepreneurship, Innovations and Quality at an enterprise.

Relating to social competences:
PEU_K01 Student is conscious about importance of entrepreneurship, quality and innovativnes

PROGRAMME CONTENT

Lectures		**Number of hours**
Lec 1	Introduction for Entrepreneurship, innovativeness and Quality Management.	3
Lec 2	Regional entrepreneurship and innovativeness. Concepts and practices.	3
Lec 3	Academic entrepreneurship and innovativeness. Concepts and practices.	3
Lec 4	Institution of supporting innovations and entrepreneurship.	3
Lec 5	Quality management . Origin, idea, concepts and practices	3
Lec 6	Quality management at IT sector.	3
Lec 7	Process of implementing quality management at an enterprise.	3
Lec 8	Benchmarking as a modern management tool for support quality.	3
Lec 9	General remarks and summary.	3
Lec 10	Written test.	3
	Total hours	30

TEACHING TOOLS USED

N1. Lecture supported by Multimedia
N2. Selected case studies for better illustrating

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 - PEU_W02, PEU_U01,	Estimation the student activity by checking list of presence (lecture)
F2	PEU_W01 - PEU_W02, PEU_U01	Estimation the knowledge by preparing team work relating to entrepreneurship
F3	PEU_K01	Assessment of creative thinking by discussion activity on classes.
P		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Kotler P., Trias De Bes F., „Innowacyjność przepis na sukces" Dom Wydawniczy Rebis, Poznań 2013 [2] Bank J., „Zarządzanie przez jakość", Felberg SJA, Warszawa 2000 [3] Tidd j., Bessant J., Zarządzanie innowacjami – Integracja zmian technologicznych, rynkowych i organizacyjnych, Oficyna Wolters Kluwer business, Warszawa 2011 **SECONDARY LITERATURE:** [1] Świda A., **"Strategic Management**", Wroclaw University of Technology, Wrocław 2011 [2] The Oxford Handbook of Innovation, Oxford University Press 2005 [3] Drucker P.F. "Zawód menedżer " MT Biznes sp.z o.o. 2004
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PhD Adam Świda, adam.swida@pwr.edu.pl

FACULTY OF ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Wstęp do programowania**
Name of subject in English:	**Introduction to Programming**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00002**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		45		
Number of hours of total student workload (CNPS)	120		120		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course	**X**				
Number of ECTS points	**8**				
including number of ECTS points for practical (P) classes			4		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	2		4		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1 Acquisition of basic knowledge on computer algorithms, how they are presented and analyzed. Getting familiar with standard algorithms processing large amounts of data, i.e.: searching, aggregating and sorting.

C2 Learning the basic programming constructs which are common to most of algorithmic languages: types, variables, conditional branching, looping, functions with arguments, recursion, arrays, lists, files. Getting Acquainted with selected forms of dynamic and complex data structures: list, stack, queue and tree.

C3 Acquiring the ability of the structural and procedural programming in C or C++, and using the integrated development environments to improve the processes of editing, compiling and testing multi-file programming projects.

C4 Update and development of the knowledge in the area of information technologies and improving the skills in its use in engineering work.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Has a basic knowledge of modern programming languages and paradigms. Knows fundamental principles and structures to represent algorithm in the form of flowcharts. Knows the basic algorithms for searching, aggregation and sorting of the data.

PEU_W02 Knows the syntax, semantics, programming constructs and concepts specific to structured and procedural programming in C or C++. Understands concepts of iteration, recursion, memory organization, pointer arithmetic, dynamic resource allocation and release. Has the knowledge of the selected dynamic and complex data structures.

PEU_W03 Has the knowledge of modern software tools, information technologies and office software packages supporting the work of the programmer.

relating to skills:

PEU_U01 Can represent an algorithm in the flowchart form. Can construct a solution for simple programming tasks that require the use of several branches, loops or recursion.

PEU_U02 Can properly structure the program code and data in C/C++, in accordance with the principles of structured and procedural programming. Can define and invoke functions, choose the way of passing the input and output parameters. Can define, initialize and process basic data representations: arrays, strings, structures and their combinations.

PEU_U03 Can appropriately use pointers and dynamic memory management, including proper allocation / deallocation procedures. Is able to design and program a set of functions that hide implementation details for complex and dynamic data structures. Can program the data storage operations in non-volatile memory using file-streams.

PEU_U04 Can use the integrated development environment to configure, edit, and test single-threaded console applications.

PEU_U05 Can effectively use business-office packages for preparing technical documentation, using spreadsheets for automating engineering calculations. Can extend their functionalities by programming new functions and macros.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	The algorithms and methods for their representation. The dominant programming paradigms. The flowcharts. The stages and tools used during software development. Standards of programming languages. The overall structure, syntax and semantics of the program in C or C++. Examples of source code for simple console applications.	2
Lec 2	Computer data and their representations. Data types and ranges of values. Program variables, variable declaration and initialization. The visibility of identifiers. Storage classes. Predefined scalar types and user defined types (typedef). Logic, bitwise and arithmetic operators. Rules for calculation of algebraic expressions. The standard mathematical functions. Dealing with streams and basic input/output operations. Dialogue with the user in text mode. Formatted input and output using standard libraries <stdio.h> <iostream>.	2
Lec 3	Basic programming instructions: assignment, conditional selection and choice. Controlling the flow of the algorithm, folding and nesting conditional instructions.	2

	Examples of algorithms that process small amounts of data (without using a loop). The concept of iterations in the program. The types of loops: while, do-while, for. Terms of completion and nesting the loops. Instructions to break or continue the loop. Simple iterative algorithms: counting, searching the minimum or maximum, summing up the data values retrieved from the stream.	
Lec 4	Arrays in C/C++. Array declaring, defining and indexing. Processing array data using a loop. One-dimensional and multi-dimensional arrays.	2
Lec 5	Functions and procedures in programming languages. Declaring, defining and invoking the function. Parameter-less functions. Explicit passing of the data via the argument list or the return statement. Passing arguments by value and by reference. Default values for arguments. Overloaded functions. Inline functions. Recursion.	2
Lec 6	Computer memory addresses, pointers to variables and memory, pointers arithmetic in C/C++. The relationship between pointers and arrays. Working with arrays using the pointer notation i. Passing arguments to the function by address. Standard C functions which operate directly on computer memory <mem.h> (memset, memcpy, memcmp, memmove, etc.)	2
Lec 7	Array representation of strings in C/C++. Declaring, defining, and manipulating the strings. Standard C library <string.h> (strcpy, strcmp, strcat, strlen, etc.). Examples of user-defined functions for processing textual data.	2
Lec 8	Program specification, testing, error handling, code documentation. Midterm (forming) exam	2
Lec 9	Recursion and recursive algorithms. Binary search and sorting of the arrays.	2
Lec 10	Structural type - the concept of structures in C/C++. Definition, declaration and initialization of structural variables. Nesting of composite types (structures and arrays). An example of a simple in+memory database using the representation in the form of arrays of structures.	2
Lec 11	Support for external memory in the form of raw data files. Random access and text files. Procedural <stdio.h> and object-oriented <fstream> <stream> libraries for standard file operations. Input and output operations for the characters, strings and formatted data. Binary data - block files. Portability of the data representation between different operating systems. Standards for exchange data files between applications written in C/C ++ and popular office suites (editors, spreadsheets).	2
Lec 12	Dynamic memory allocation. Allocating and freeing the allocated memory (malloc, calloc, free, new and delete operators). Heap overflow and dynamic data corruption. Dynamic allocation and reallocation of arrays of a specified size.	2
Lec 13	The complex pointer data structures. The array of pointers to simple variables, array of pointers to arrays, dynamic array of pointers to dynamic strings. Pointers to functions. Standard qsort function.	2
Lec 14	Dynamic and recursive data structures: the pointer-driven list, stack, queue, priority queue, binary tree, and their properties.	2
Lec 15	Utilizing the integrated office suites (editors, , spreadsheets, databases) in engineer work. Advanced processing capabilities of technical text documents and data in spreadsheets, through programming of new functions and macros.	2
	Total hours	**30**

Laboratory		Number of hours
Lab 1	Overview of the program and the organization of the laboratory classes. Workplace training in health and safety. Writing algorithms using flowcharts language. Setting up development environment (e.g. Windows/ Visual Studio or Linux/Emacs/gcc). An example of a console program using simple variables, assignment statements, and console input output operations. Editing, compiling, running and debugging the program. Guidelines for the use of integrated office packages for creating the technical documentation and reports on the implementation of laboratory tasks.	3
Lab 2	Representation of standard data types in C. Appropriate selection of the data type for variables. Data representation constraints. The dialogue with the user using standard printf and scanf functions. Formatting data (construction of format strings containing different control sequences). Calculating mathematical and boolean expressions in C/C++.	3
Lab 3	Exercises with the creation of example programs illustrating the use of basic C/C++ constructs and concepts: assignment, conditional branching (if, if-else), selection (switch, case, break, default). Nesting branching instructions.	3
Lab 4	The concept of iterations. The role and selection of the control variables for the loop. Loop breaking constructs (while, do-while, for). The equivalence of the loop.	3
Lab 5	Continuation of exercises with the creation of programs that illustrate the use of the user loop. Standard iterative algorithms: counting, summing, searching the maximum and minimum, calculation of the mathematical series.	3
Lab 6	Structured and procedural programming. Sub-division of tasks into functions, the concept of program menu. Visibility range and overriding the identifiers. Exercises with creating user-defined functions. Parameterless functions. Local variables. Passing parameters through global variables. The functions with explicit argument list. Passing arguments by value, reference and address.	3
Lab 7	Exercises with the creation of programs that illustrate the use of the array data representation. Processing arrays using a loop. Basic array processing algorithms (filling, comparing items, search, move, delete, add items).	3
Lab 8	Dynamic arrays (array with a counter of used items). Selected algorithms for processing arrays: linear and binary search, bubble sort and insertion sort. Parameterization of algorithms. Appropriate selection of the method for passing input/output parameters between the functions.	3
Lab 9	Text processing functions. Code analysis of the standard functions <string.h> library. User-defined functions for character string processing. Dynamic allocation and reallocation of memory. One-dimensional arrays of variable size. Pointer arithmetic and pointer casting. Exercise with accessing the memory through pointers.	3
Lab 10	Exercises with the creation of programs illustrating the processing of textual data, represented as an array of characters. Accessing the variables using pointers. Programs that use dynamic allocation and re-allocation of one-dimensional arrays. Debugging and testing the correctness of the programs.	3
Lab 11	Implementing simple in-memory database using representation in the form of an array of structures (or array of pointers to dynamic structures). Extending the functionalities of database program: adding archiving operations in the external memory (in the form of text or binary files).	3
Lab 12	The structural decomposition of large programs and complex data representation. Discussion and practice the representation of simple in-memory database (using an array of structures). User defined data type, enumeration. Encoding data using the dictionary.	3

Lab 13	Exercises with data storage in external memory using file streams. Text and binary representation of numerical data. Error detection during file stream input / output operations. Controlling the location of the file position indicator. Basic algorithms for sequential processing of text and raw binary files. Export/import of numeric and text data into popular office spreadsheet program.	3
Lab 14	User-defined implementation of selected dynamic data structure: the linked list, queue, priority queue or a tree. Exercises with creating programs using recursion.	3
Lab 15	Utilizing standard business office suites. Exercises with advanced formatting techniques of technical documents and performing engineering calculations using spreadsheets. Automation of work by programming new functions and macros.	3
	Total hours	**45**

TEACHING TOOLS USED
N1. Traditional lectures using multimedia projector N2. Individual work - self-implementation of appointed laboratory programs N3. Program code inspections carried out by the laboratory instructor N4. Individual work - self-study and preparation for lecture tests

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 – PEU_W03	Written test during the lecture. In the case of an additional test in the middle of the semester, the assessment F1 is a weighted sum of (1/3*F3 + 2/3*F4), where: F3 – evaluation of the midterm test F4 – evaluation of the final lecture test
F2	PEU_U01 – PEU_U05	Assessment of the reports documenting progress of laboratory exercises. Code inspection of the programs created by student, carried out by laboratory instructor.
P = 0.4*F1 + 0.6*F2, all partial evaluations must be positive		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Brian Kernighan, Dennis Ritchie, The C Programming Language, 1988
[2] Greg Perry, Dean Miller, C Programming Absolute Beginner's Guide, 3rd Edition, 2013
[3] Bjarne Stroustrup, The C++ programming language, 4th ed., 2013
[4] Stanley Lippman, Josée Lajoie, C++ primer, 5th ed., 2013,

SECONDARY LITERATURE:

[1] Niklaus Wirth, Algorithms + Data Structures = Programs, 1976
[2] Robert Sedgewick, Algorithms in C, 3rd Edition, 2001
[3] K.N. King, C Programming: A Modern Approach, 1996
[4] Dan Gookin, C for Dummies, Volume 1, 1994
[5] Alex Allain, Jumping into C++2013

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FACULTY OF ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Prawo autorskie**
Name of subject in English:	**Copyright**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**optional**
Subject code:	**PRZ000339**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				
Number of hours of total student workload (CNPS)	60				
Form of crediting	crediting with grade				
For group of courses mark (X) final course					
Number of ECTS points	**2**				
including number of ECTS points for practical (P) classes					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,0				

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. general knowledge of creativity and creativity
2. general knowledge of intellectual property

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SUBJECT OBJECTIVES

C1 To learn and acquire basic knowledge about copyright.
C2 To get to know and acquire knowledge about the rights and ways of protecting author's creativity.

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:
PEU_W01 knows and understands Copyright Personal and Property Rights.

Relating to skills:
PEU_U01 is able to interpret, explain and evaluate the nature and meaning of legal rules.

Relating to social competences:
PEU_K01 Student is conscious about importance of entrepreneurship, quality and innovativeness

PROGRAMME CONTENT

Lectures		**Number of hours**
Lec 1	Subject matter and sources of copyright. Concept of copyright work. Dependent and employee works of authorship.	2
Lec 2	Author's personal and property rights. Conditions of copyright protection.	2
Lec 3	Public and private use. Right of quotation.	2
Lec 4	Contents and form of a contract on transfer of author's economic rights	2
Lec 5	Using author's works - use, leasing and licence.	2
Lec 6	Legal nature of a licence agreement. Types of licences. Creative Commons (CC) licences	2
Lec 7	Transfer or granting of a licence to copyright and VAT tax	2
Lec 8	Rules for applying 50% of tax-deductible costs to revenue earned from the disposal or use of copyright.	2
Lec 9	Legal responsibility for copyright infringement	2
Lec 10	Contents of copyright in the network environment. Ways of exploiting a work Permitted public use of works in a network environment.	2
Lec 11	Dissemination and publication of copyright works in the Internet	2
Lec 12	Creativity and works in the Internet - principles of protection of the website (home-pages) and web pages (web-pages).	2
Lec 13	Creation, use and protection of multimedia works.	2
Lec 14	The issue of author's economic rights as an object of contribution to a company.	2
Lec 15	Collective management of copyright and related rights.	2
	Total hours	**30**

TEACHING TOOLS USED

N1. Lecture supported by Multimedia

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01, PEU_U01, PEU_K01,	Written test
P=F1		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1]Golat R., Prawo autorskiei prawa pokrewne, Wyd. C. H. Beck, seria skrypty, Warszawa 2018.

[2] Błońska B., Bojańczyk K., Gołaszewska A., Krasowicz S, Krysińska J., Machałą W. (red.nauk.), Nowotnik-Zajączkowska M., Rząa G., Sarbiński R. M. (red. nauk.), Siciarek M., Sobczyk - Sarbińska K., Świętczak M., Urbański A., Zalewski A., Prawo autorskie i prawa pokrewne. Komentarz, Wyd. Wolters Kluwer Polska, Warszawa 2019.

[3] Ustawa o prawie autorskim i prawach pokrewnych z dnia 4 lutego 1994 r., w: Dz. U. Z 2006.90.631.z poźn.zm.

SECONDARY LITERATURE:

[1]Barta J., Markiewicz R., Prawo autorskie, Wyd. Wolters Kluwer, Warszawa 2016.

[2]Golat R., Umowy z zakresu prawa autorskiego i praw pokrewnych – wzory i komentarze, Wyd. Difin, Warszawa 2001.

[3] Okoń Z., Prawo autorskie i prawa pokrewne. Komentarz., Wyd., Lex 2015

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Zał. nr 5 do ZW 16/2020

FACULTY OF ELECTRONICS (W4)

SUBJECT CARD

Name of subject in Polish:	**Elektronika**
Name of subject in English:	**Electronics**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00003**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	45	45	30		
Number of hours of total student workload (CNPS)	90	90	60		
Form of crediting	crediting with grade	crediting with grade	crediting with grade		
For group of courses mark (X) final course	**x**				
Number of ECTS points	**8**				
including number of ECTS points for practical classes (P)		3	2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,5	1,5	1		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Differential and integral calculus of one variable.
2. Complex numbers.

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SUBJECT OBJECTIVES

C1 basic knowledge about the methods of analysis of DC and AC circuit and gaining of skills to use these methods.
C2 basic knowledge in the field of logic.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 - have a basic knowledge of methods of analysis for DC and AC circuits.
PEU_W02 - knows the basic theorems of circuit theory,
PEU_W03 - have a basic knowledge of calculus based on Laplace transformation.
PEU_W04 - knows the definitions of transmission system operators, knows the physical meaning of frequency characteristics of the system.
PEU_W05 - knows how to express periodic function as a Fourier series, knows the physical

interpretations of the series; knows the method of linear circuit analysis with periodical excitation.
PEU_W06 - knows the definition and concept of four-terminal network, has a basic knowledge of how to describe four-terminal networks using their internal parameters.
PEU_W07 - knows the concept of the transmission line and phenomena occurring in it.
PEU_W08 - knows the principles of elementary logic circuits.

relating to skills:
PEU_U01 - is able to analyze elementary DC and AC sinusoidal excited circuits.
PEU_U02 - can use symbolic method for the elementary analysis of linear circuits.
PEU_U03 - can determine the frequency characteristics of the system and analyze transients.
PEU_U04 - can nominate Fourier coefficients of a periodic function, can determine the power and RMS value of periodic signal based on discrete amplitude spectrum.
PEU_U05 - is able to describe a two-port circuits with a proper matrix.
PEU_U06 - can analyze elementary logic circuits.

relating to social competences:

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Voltage and Current, Resistance, Ohm's Law, Power, and Energy	2
Lec 2	Network Theorems	2
Lec 3	Capacitors, Inductors, Magnetic Circuits	2
Lec 4,5	Sinusoidal Alternating Waveforms. The Basic Elements and Phasor Methods	4
Lec 6	Series and Parallel ac Circuits, Series-Parallel ac Networks Methods of Analysis (ac)	2
Lec 7	Network Theorems (ac), Power (ac	2
Lec 8	Resonance	2
Lec 9	Transformers	2
Lec10,11	Polyphase Systems	4
Lec 12	Transient analysis, time response	2
Lec 13	Transient analysis	2
Lec 14	Pulse Waveforms and the R-C Response	2
Lec15,16	Non-sinusoidal Circuits (Fourier series)	4
Lec 18	Transfer function; Decibels, Filters, and Bode Plots	2
Lec 19	Two port circuits	3
Lec 20	Transmission lines (Distributed parameter systems)	2
Lec 21	Digital logic, (gates, flip-flops)	2
Lec22,23	Summary	4
	Total hours	**45**

Classes		**Number of hours**
Cl 1,2	Analysis of elementary DC circuits.	4
Cl 3,4	Physical laws in electrotechnics ; KVL and KCL, current loop analysis and voltage node analysis	4

Cl 5,6	sinusoidal excitation analysis of AC circuits (complex numbers)	4
Cl 7,8	Thévenin i Norton theorems and superposition rule application	4
Cl 9,10	Power factor compensation, power matching.	4
Cl 11,12	Fourier series practice	4
Cl 13,14	Two-port circuits, internal and external parameters	4
Cl 15	Simple circuits analysis by means of differentia equations	3
Cl 16,19	operational method of analysis of linear circuits	8
Cl 20	Frequency response of a circuit. Bode plot.	2
Cl 21,22	Analysis and synthesis of elementary logical circuits	4
	Total hours	**45**

Laboratory		**Number of hours**
Lab 1	Introduction	2
Lab 2	Basic circuits theorems	4
Lab 3	Operator transmittance; transient analysis	4
Lab 4	Two-port circuits parameters measurements	4
Lab 5	Fourier series	4
Lab 6	Transmission line model	4
Lab 7	Logical circuits, Gates and flip-flops.	4
Lab 8	Summary.	4
	Total hours	**30**

TEACHING TOOLS USED
N1.Chalk board N2. Projector, computer with PowerPoint N3. Lab stand N4. Self-study N5. Consultations N6. Two person team work (in special cases 3 persons team)

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01- PEU_W08	test
F2	PEU_U01- PEU_U06	Oral answers and/or quizzes and/or final test
F3	PEU_U01- PEU_U06	Quizzes, lab work, reports
P = (F1+F2+F3)/3; all F1, F2 i F3 must be positive		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] R. L. Boylestad – Introductory Citcuits Analysis, Pearson, Prentice Hall, 2012 11th edition **SECONDARY LITERATURE:** [1] S. Osowski, K. Siwek, M. Śmiałek – Teoria obwodów, Wydawnictwo Politechniki Warszawskiej, 2006 [2] W. Wolski, Teoretyczne podstawy techniki analogowej, Wydawnictwo PWr, 2007, [3] Literature suggested during classes.
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Zał. nr 5 do ZW 16/2020

FACULTY **Electronics**

SUBJECT CARD

Name of subject in Polish:	**Metrologia**
Name of subject in English:	**Metrology**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00001**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15	15	30		
Number of hours of total student workload (CNPS)	60	30	30		
Form of crediting	Crediting with grade	Crediting with grade	Crediting with grade		
For group of courses mark (X) final course	**X**				
Number of ECTS points	**4**				
including number of ECTS points for practical (P) classes		1	2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,5	0,5	1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

C1 – Acquiring knowledge in the field of measurement theory
C2 – Acquiring on techniques of electrical and nonelectrical quantities measurements
C3 – Acquiring knowledge and skills in measurement results analysis
C4 – Acquisition of skills in measurements planning and performing
C5 – Acquisition of skills in preparing reports on performed measurements

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 – interprets basic concepts in the field of metrology
PEU_W02 – explains methods of measurement results analysis
PEU_W03 – describes construction and operation of measuring devices
PEU_W04 – characterises measurements of electrical quantities
PEU_W05 – characterises measurements of nonelectrical quantities

relating to skills:
PEU_U01 – knows applications and can use and maintenance measurement devices
PEU_U02 – can design and perform measurements of basic electrical quantities
PEU_U03 – can apply basic laws and theorems to measurement circuits
PEU_U04 – can analyse measurement results and point to possible sources of errors
PEU_U05 – can draw up a protocol and prepare a report on performed measurements

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec1	Introduction to metrology	1
Lec2	Measurement units and systems, standards of electrical quantities, frequency and time	2
Lec3	Direct and indirect measurement methods	1
Lec4	Measurement accuracy and approaches to its assessment	2
Lec5	Methods for the analysis of measurement results	1
Lec6	General characteristics of measurement devices; construction and operation of analog meters	1
Lec7	Construction and operation of digital and microprocessor-based meters	1
Lec8	Measurements of constant electrical quantities	1
Lec9	Measurements of signal parameters	1
Lec10	Measurements of time-variable electrical quantities	1
Lec11	Measurements of electrical impedance	1
Lec12	Principles of nonelectrical quantities measurement	1
Lec13	Summing-up knowledge on metrology	1
	Total hours	**15**

Classes		**Number of hours**
Cl1	Organization of classes	1
Cl2	Basic laws and theorems of electrical circuits	4
Cl3	Limiting errors of direct measurement	2
Cl4	Analysis of measurement of voltage and current	2
Cl5	Limiting errors of indirect measurement	2
Cl6	Analysis of measurement of electrical resistance	2
Cl7	Summing-up skills	2
	Total hours	**15**

Laboratory		Number of hours
Lab1	laboratory organization and safety regulations	3
Lab2	Measurement devices – maintenance and using	3
Lab3	Oscilloscope - principle of operation, maintenance and using	3
Lab4	DC voltage measurements	3
Lab5	DC current measurements	3
Lab6	Measurements of electrical resistance	3
Lab7	Measurements of the voltage and current source parameters	3
Lab8	RMS voltage measurement of periodic signals	3
Lab9	Measurements of frequency and phase of periodic signals	3
Lab10	Reserve term / own work	3
	Total hours	**30**

TEACHING TOOLS USED
N1. Traditional lectures with the use of multimedia presentations N2. Written instructions for the classes N3. Discussion on solved problems N4. Short tests of preparation to classes N5. Preparing protocols and reports on performed measurements N6. Individual consultations N7. Own work

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 – PEU_W05	Final test
F2	PEU_U03, PEU_U04	Short tests, discussions, final test
F3	PEU_U01, PEU_U02, PEU_U05	Short tests, discussions, protocols and reports
C = (F1 + F2 + F3)/3 (positive grade under condition: F1>2 & F2>2 & F3>2)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Czichos H., Saito T., Smith L.E.: Springer Handbook of Metrology and Testing. Springer-Verlag, Berlin Haidelberg, 2011.
[2] Bucher J.L. (ed.): The Metrology Handbook (2nd Edition), Quality Press, Milwaukee, WI 2012.
[3] Webster J.G. (ed.): Measurement, Instrumentation and Sensors Handbook. CRC Press LLC, Boca Raton 1999.
[4] Guide to the Expression of Uncertainty in Measurement. ISO/IEC Guide 98-3:2008.

SECONDARY LITERATURE:

[1] Chwaleba A., Poniński M., Siedlecki A.: Metrologia elektryczna. WNT, Warszawa 2003.
[2] Sydenham P.H. (ed.): Handbook of Measurements, vol. 1&2. John Wiley & Sons Ltd., Chichester 1982.
[3] Tumański S.: Technika pomiarowa. WNT, Warszawa 2007-2013.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Adam Polak, Ph.D., D.Sc, adam.polak@pwr.edu.pl

FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Systemy i środowiska programistyczne**
Name of subject in English:	**Programming Systems adn Environments**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00010**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	60		60		
Form of crediting	Examination		Crediting with grade		
For group of courses mark (X) final course	**X**				
Number of ECTS points	**4**				
including number of ECTS points for practical (P) classes			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1		1		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.

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SUBJECT OBJECTIVES

C1 Gaining understanding of the operating systems and API libraries, their advatages and limitations.
C2 Mastering the principles of using system functions and APIs, buiding simple GUI and multithread applications, porting software to mobile devices.

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01 knows how an operating system is designed, understands system functions pertaining to process and memory management, interprocess communication.
PEU_W02 knows how to use multithread and GUI libraries in various environments
PEU_W03 knows how to develop programs using an OOP language (e.g. Java)

relating to skills:

PEU_U01 can develop simple multithread applications

PEU_U02	can develop simple GUI applications
PEU_U03	is able to port programs to mobile devices (e.g. with Android OS)

PROGRAMME CONTENT		
Lecture		**Number of hours**
	Operating systemsenvironment	
Lec 1	Introduction to operating systems, system functions	2
Lec 2	Memory management and virtual memory	2
Lec 3	Processes and process management, system functions for process and memory management	2
Lec 4	Process synchronization, semaphores	2
	Application programming interfaces (API)	
Lec 5	Program compilation, linking and loading, static and dynamic libraries	2
Lec 6	Graphical user interfaces and toolkits (Windows, X System)	2
Lec 7	Multithread programming (POSIX threads, Windows threads)	2
	Java environment	
Lec 8	Java language	4
Lec 9	Java Virtual Machine, IDE, build managers	2
Lec 10	Java threads and synchronization	2
Lec 11	Java graphical user interface libraries	4
	Android programming	
Lec 12	Android platform and programming environment	2
Lec 13	Android GUI programming	2
	Total hours	**30**
Laboratory		**Number of hours**
Lab 1	Developing multithread server applications in C++	8
Lab 2	Developing GUI applications in Java	8
Lab 3	Java multithread applications	8
Lab 4	Android Java programming	6
	Total hours	30

TEACHING TOOLS USED
N1. Traditional lecture using video projector
N2. Activity in laboratory
N3. Consultations
N4. Individual work – literature study and preparation for the test
N5. Individual work – study to prepare for the laboratory tasks

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 - PEU_W03	Written test
F2	PEU_U01 - PEU_U03	Assessment of laboratory activity and documentation
P = 0,4*F1+0,6*F2 if F1>2 and F2>2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] A. Silberschatz, P.B. Galvin, G. Gagne, Operating systems concepts
[2] B. Eckel, Thinking in Java
[3] Ch. Schildt, Java, A Beginner's Guide
[4] Ch. Collins, M. Galpin, M. Kaeppler, Android in Practice

SECONDARY LITERATURE:

[1] A.S. Tanenbaum, Operating System: Design and Implementation
[2] J. Gray, Interprocess Communications in Linux: The Nooks and Crannies
[3] D.Griffiths, D.Griffiths, Head First Android Development

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Tomasz Walkowiak, tomasz.walkowiak@pwr.edu.pl

FACULTY W4 / DEPARTMENT K4

SUBJECT CARD

Name of subject in Polish:	**Technologia elektroniczna**
Name of subject in English:	**Electronic technology**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00006**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	60		90		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course	**x**				
Number of ECTS points	**5**				
including number of ECTS points for practical (P) classes			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1		2		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1 Earning fundamental knowledge in designing mechanical and electronic units
C2 Earning fundamental knowledge in the field of mechanical units production
C3 Earning fundamental knowledge in the field of electronic units production
C4 Getting skills in a design of electronic and mechanical devices

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01 – Student knows the principles used in a design and documentation preparation processes of mechanical units
PEU_W02 – Student possesses knowledge required to choose a technology of mechanical unit production
PEU_W03 – Student knows the principles used in a design process of electronic units
PEU_W04 – Student possesses knowledge required to choose a technology of electronic unit production
PEU_W05 – Student knows the principles of testing electronic units

relating to skills:
PEU_U01 – Student can use software tools in a mechanical design process
PEU_U02 – Student can effectively use datasheets in a design process
PEU_U03 – Student can use software tools in an electronic design process
PEU_U04 – Student can choose a right production technology for designed unit

relating to social competences:

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Introduction to design process of electronic and mechanical units. CAD/CAE software tools.	2
Lec 2	Fundamentals of technical drawing. Drawing rules of sketches and cross-sections.	2
Lec 3	Principles of dimensioning and technical documentation preparation.	2
Lec 4 Lec 5	Fundamentals of mechanical unit production. Principles of choosing a production technology, material and machine tool.	4
Lec 6 Lec 7 Lec 8	Production technology of electronic components. Electrical and thermal parameters and available packages. Component selection taking into account their working conditions.	6
Lec 9 Lec 10	Production technology of printed circuit boards. Production and design of PCBs and their parameters optimization.	4
Lec 11 Lec 12	Electronic circuits assembly technology. Review of practical solutions.	4
Lec 13 Lec 14	Reliability of electronics devices. Review of test and examination methods. Introduction to IPC norms.	4
Lec 15	Summary	2
	Total hours	30

Laboratory		**Number of hours**
Lab 1	Introduction to CAD software tool	2
Lab 2 Lab 3	Sketches and constraints in 2D	4
Lab 4 Lab 5	Creating solids	4
Lab 6	Designing cases. Electronic circuits and electro-mechanical components integration	2
Lab7	Creating a documentation of a project	2
Lab 8	Summary	1
	Total hours	15

TEACHING TOOLS USED

N1. Lecture with a usage of a chalkboard and a multimedia presentation
N2. Laboratory classes – discussion of used solution
N3. Consultations

N4. Independent work – preparation to laboratory classes N5. Independent work – self-study and preparation to final test

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 – PEU_W05	Written test
F2	PEU_U01 – PEU_U02	Tests, assessment of laboratory work and reports
F3	PEU_U03 – PEU_U04	Tests, assessment of laboratory work and reports
P = 0.6*F1+0.2*F2+0.2*F3, all forming grades have to be positive		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Introduction to Basic Electricity and Electronics Technology, Earl D. Gates, Delmar Cengage Learning
[2] Practical Electronics for Inventors, Paul Scherz, Simon Monk, Tab Books, 3rd edition
[3] The Circuit Designer's Companion, Peter Wilson, Newnes, 3rd edition
[4] An Introduction to Mechanical Engineering, Jonathan Wickert, Kemper Lewis, CL Engineering, 3rd edition
[5] Technical Drawing for Engineering Communication, David E. Goetsch, Raymond L. Rickman, William S. Chalk, Delmar Cengage Learning, 7th edition

SECONDARY LITERATURE:

[1] Electronic Components and Technology, Stephen Sangwine, CRC Press, 3rd edition
[2] Electronic, Magnetic and Optical Materials, Pradeep Fulay, Jung-Kun Lee, CRC Press

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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FACULTY OF ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Programowanie w praktyce inżyniera i naukowca**
Name of subject in English:	**Scientific & Engineering Programming**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00007**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	60		90		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course	**X**				
Number of ECTS points	**5**				
including number of ECTS points for practical (P) classes	0		3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1		1		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic programming and object-oriented programming

SUBJECT OBJECTIVES

C1 To acquaint with programming tools and environments utilised in scientific and engineering work.
C2 To develop skills of symbolic computation and numeric simulation tools utilisation.
C3 To explain problems and principles of experiment preparation and implementation in programming environments.

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01 – knows the basic of engineer's and scientist's programming tools
PEU_W02 – understands the role of system/experiment specification and implementation phases
PEU_W03 – understands the role of tools selection
PEU_W04 – knows the methods for result visualisation and analysis
PEU_W05 – knows the MATLAB environment and programming language
PEU_W06 – knows the Mathematica environment and programming language

relating to skills:

PEU_U01 – can use MATLAB framework
PEU_U02 – can use Mathematica environment
PEU_U03 – can model and simulate dynamical systems
PEU_U04 – can perform basic symbolic computations
PEU_U05 – can acquire, visualise, and analyse measurement data

relating to social competences:

PEU_K01 – understands the need for self-study and knowledge sharing

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Introduction to the course. Overview of scientific and engineering tasks	2
Lec 2	System/experiment specification and implementation. Results visualisation and analysis	3
Lec 3	Survey on scientist's/engineer's tools: programming languages and environments, libraries, and physics engines	3
Lec 4	Introduction to Mathematica	4
Lec 5	Differential equations in Mathematica	2
Lec 6	Symbolic computation for dynamical systems modelling in Mathematica	2
Lec 7	Data acquisition and code generation in Mathematica	2
Lec 8	Introduction to MATLAB	4
Lec 9	Introduction do Simulink	2
Lec 10	Differential equations in MATLAB	2
Lec 11	Numerical methods in MATLAB	2
Lec 12	Data acquisition and control in MATLAB	2
	Total hours	30

Laboratory		**Number of hours**
Lab 1	Introduction to the laboratory environment and tools	2
Lab 2	Mathematica basic programming	6
Lab 3	Dynamical systems simulation in Mathematica	4
Lab 4	Dynamical systems modelling with symbolic computation in Mathematica	4
Lab 5	MATLAB basic programming	6
Lab 6	Dynamical systems simulation in MATLAB	4
Lab 7	MATLAB application for measurement data acquisition, visualisation, and	4

	analysis	
	Total hours	30

TEACHING TOOLS USED

N1.Traditional lecture using video projector
N2. Laboratory
N3. Consultation
N4. Independent work – preparation for the laboratory
N5. Independent work – self study

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 - PEU_W06; PEU_K01	test
F2	PEU_U01 - PEU_U05; PEU_K02	active participation in classes, test
P =0,4*F1 + 0,6*F2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Bruce F. Torrence, Eve A. Torrence, "The Student's Introduction to Mathematica and the Wolfram Language", Cambridge University Press, 2019 [2] Edward B. Magrab, "An Engineer's Guide to Mathematica", Wiley, 2014
[3] D. Báez-López, D. A. Baez Villegas, "MATLAB Handbook with Applications to Mathematics, Science, Engineering, and Finance", Chapman & Hall/CRC, 2019
[4] G.P. Syrcos, I.K. Kookos, "Introduction to Control System Design Using MATLAB, 2e", Papasotiriou Inc., 2005
[5] D. J Agans, "Debugging: The 9 Indispensable Rules for Finding Even the Most Elusive Software and Hardware Problems", Amacom, 2002

SECONDARY LITERATURE:

[1] lecture notes
[2] internet resources

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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Zał. nr 5 do ZW 16/2020

FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Elementy elektroniczne**
Name of subject in English:	**Electronic Components and Sensors**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00016**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	45	15	30		
Number of hours of total student workload (CNPS)	120	30	90		
Form of crediting	Examination	Crediting with grade	Crediting with grade		
For group of courses mark (X) final course	**X**				
Number of ECTS points	**8**				
including number of ECTS points for practical (P) classes		1	3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,5	0,5	1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.

SUBJECT OBJECTIVES

C1 – Acquisition of basic knowledge on the design, operation and applications of semiconductor electronic components.
C2 – Acquiring basic knowledge on sensors and sensor systems
C3 – Acquisition of skills in determining parameters of selected electronic components
C4 – Acquisition of skills to design, create and implement applications for data collection, processing and presentation

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 – describes principles of operation of basic electronic components
PEU_W02 – describes structure, characteristics and applications of basic electronic components
PEU_W03 – defines basic characteristics of sensors
PEU_W04 – characterises applications of sensors and interfaces in measurements of physical quantities

relating to skills:
PEU_U01 – calculates parameters of selected electronic components and their circuits
PEU_U02 – uses the LabVIEW programming environment for data acquisition, processing and presentation

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec1	Organizational matters, conditions of gaining credit.	1
Lec2	Passive electronic components - construction, types, principle of operation, basic parameters and characteristics.	3
Lec3	Physical principles of semiconductor and their energy band model. Types of semiconductor materials and their short characteristics.	2
Lec4	The physical structure of the p-n junction, polarization and static current-voltage characteristic.	2
Lec5	Types of semiconductor diodes: rectifier diodes, universal, Zener, Schottky etc. Parameters and characteristics.	2
Lec6	Bipolar transistors. Construction and operation of PNP and NPN transistors principle of polarity. Configuration OB, OE, OC. Current gain. The characteristics and parameters - limiting the scope of usage.	2
Lec7	Bipolar junction transistors - graphical analysis, hybrid pi model, input resistance, frequency limit, the effect of temperature on the operation and performance of the transistor.	2
Lec8	Junction Field Effect Transistors JFET - basic structures, characteristics, parameters, static work, dynamic work with small signals, the frequency characteristics.	2
Lec9	Field effect transistors with insulated gate MOSFET - structure, types, characteristics, parameters. HexFET, VDMOS and IGBT transistors – basic information.	2
Lec10	Thyristor - construction, types, principle of operation, characteristics, two-transistor model and examples of applications to power control. Triac, Diac - construction, principle of operation, characteristics and applications.	2
Lec11	Optoelectronics - basic concepts, LEDs, photoresistors, photodiode, phototransistor, silicon photomultiplier, construction, principle of operation, characteristics, parameters, examples of applications.	2
Lec12	Photovoltaic panels - construction, operation, characteristics, parameters	2
Lec13	Electronic elements for protection and suppression – properties, basic parameters and characteristics.	1
Lec14	Operational amplifiers - basic structures, characteristics, parameters, static work, dynamic work with small signals, the frequency characteristics.	1
Lec15	Batteries, accumulators and sources of energy used in electronics – basic parameters and characteristics.	2
Lec16	Photovoltaic cells - practical applications.	2

Lec17	Introduction, requirements and forms of crediting. Instrumentation components. Sensors, signal conditioning blocks, analog-to-digital converters, interface circuitry. Tools and programming environments used in the design of classical and virtual instruments.	1
Lec18	Metrological properties of sensors (sensitivity, selectivity, linearity, repeatability, accuracy). Classification of sensors.	2
Lec19	Fundamentals and electronic instruments for measurement of position, displacement, and tension	1
Lec20	Fundamentals and electronic instruments for measurement of temperature.	2
Lec21	Fundamentals and electronic instruments for measurement of pressure.	2
Lec22	Fundamentals and electronic instruments for measurement of flow.	1
Lec23	Smart sensors.	1
Lec24	Sensor networks and interfaces.	1
Lec25	Serial interfaces.	2
Lec26	IEEE488 standard. SCPI specification.	1
Lec27	Network protocols used in distributed instrumentation.	1
	Total hours	**45**

Classes		**Number of hours**
Cl1	Organizational matters, conditions of gaining credit.	1
Cl2	Resistivity and resistance, calculation resistance of wirewound, carbon film, metal film and ceramic resistors, contacts, connections, cables etc. Capacitance and capacity – calculation of capacitance, charge/discharge curve and ESR coefficient. Calculation of air coils parameters, self-inductance and mutual.	2
Cl3	Ferrite core coil – properties, parameters calculation and design. Typical problems of impulse work. Transformer – properties, parameters and simple design calculations.	2
Cl4	Test I	1
Cl5	Semiconductor diodes – exercise in calculations of simple circuits. Power loss, thermal management and typical problems of impulse work.	1
Cl6	Bipolar junction transistor – small and large signal models, exercise in h-parameter calculation. Bipolar current sources and the current mirror. Bipolar transistor in amplifier and switching circuits. Calculation of switching and conduction losses of bipolar transistors.	2
Cl7	MOSFET transistor in amplifier and switching circuits. Calculation of switching and conduction losses of MOSFET transistors.	2
Cl8	Semiconductor switching elements – thyristor, triac, diac. Calculation of power loss in a switching and basic commutation circuit.	1
Cl9	Discrete optoelectronic components – photoresistor, photodiode, phototransistor. Calculation of its basic circuit and characteristic parameters.	1
Cl10	Test II	2
	Total hours	**15**

Laboratory		**Number of hours**
Lab1	Organizational matters. Introduction to LabView. Characteristics of laboratory stands.	2
Lab2	Dataflow model. Navigating LabVIEW. Loop, conditional and sequential structures.	2

Lab3	Parts of Virtual Instrument program: front panel, block diagram, icon and connection pane. Subroutines (subvi).	2
Lab4	Simple application that illustrates the principles of creating and running programs in LabVIEW.	2
Lab5	How to change front panel objects properties during program execution? Property nodes.	2
Lab6	Implementation of the “state machine” design pattern.	4
Lab7	VISA library and rules for its use to remotely control measurement instruments.	2
Lab8	Establishment of project teams. Overview and discussion of requirements.	2
Lab9	Implementation of the measurement experiment using GPIB instruments (work in two-person teams).	10
Lab10	Results presentation.	2
	Total hours	**30**

TEACHING TOOLS USED
N1. Standard lectures with multimedia presentations N2. Discussions on problems being solved N3. Performing experimental and programming classes N4. Individual consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 – PEU_W04	Final exam
F2	PEU_U01 – PEU_U02	Two tests, Graded assignments of laboratory tasks
P = 0.5*F1 + 0.5*F2 (positive grade under condition: F1≥3 & F2≥3)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] W. Gopel, J. Hesse, J.N. Zemel (Eds): Sensors. A Comrehensive Survey. VCH, Weinheim 1991.
[2] U.K. Mishra, J. Singh: Semiconductor Device Physics and Design, Springer-Verlag, Dordrecht 2008
[3] J.M. Pieper: Automatic Measurement Control: A Tutorial on SCPI and IEEE 488.2; Rohde & Schwarz GmbH, 2014.

SECONDARY LITERATURE:

[1] P. Hauptmann. Sensoren. Prinzipien und Anwendungen. Carl Hanser Verlag, Munchen1991.
[2] Hennel J., Podstawy elektroniki półprzewodnikowej, WNT, Warszawa 2003
[3] W. Tłaczała: Środowisko LabVIEW w eksperymencie wspomaganym komputerowo. Wydawnictwo Naukowo-Techniczne. Warszawa 2002.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Prof. Janusz Mroczka, Ph.D., D.Sc., janusz.mroczka@pwr.edu.pl

Zał. nr 5 do ZW 16/2020

FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Elementy elektroniczne**
Name of subject in English:	**Electronic Components and Sensors**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00016**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	45	15	30		
Number of hours of total student workload (CNPS)	120	30	90		
Form of crediting	Examination	Crediting with grade	Crediting with grade		
For group of courses mark (X) final course	**X**				
Number of ECTS points	**8**				
including number of ECTS points for practical (P) classes		1	3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,5	0,5	1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.

SUBJECT OBJECTIVES

C1 – Acquisition of basic knowledge on the design, operation and applications of semiconductor electronic components.
C2 – Acquiring basic knowledge on sensors and sensor systems
C3 – Acquisition of skills in determining parameters of selected electronic components
C4 – Acquisition of skills to design, create and implement applications for data collection, processing and presentation

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 – describes principles of operation of basic electronic components
PEU_W02 – describes structure, characteristics and applications of basic electronic components
PEU_W03 – defines basic characteristics of sensors
PEU_W04 – characterises applications of sensors and interfaces in measurements of physical quantities

relating to skills:
PEU_U01 – calculates parameters of selected electronic components and their circuits
PEU_U02 – uses the LabVIEW programming environment for data acquisition, processing and presentation

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec1	Organizational matters, conditions of gaining credit.	1
Lec2	Passive electronic components - construction, types, principle of operation, basic parameters and characteristics.	3
Lec3	Physical principles of semiconductor and their energy band model. Types of semiconductor materials and their short characteristics.	2
Lec4	The physical structure of the p-n junction, polarization and static current-voltage characteristic.	2
Lec5	Types of semiconductor diodes: rectifier diodes, universal, Zener, Schottky etc. Parameters and characteristics.	2
Lec6	Bipolar transistors. Construction and operation of PNP and NPN transistors principle of polarity. Configuration OB, OE, OC. Current gain. The characteristics and parameters - limiting the scope of usage.	2
Lec7	Bipolar junction transistors - graphical analysis, hybrid pi model, input resistance, frequency limit, the effect of temperature on the operation and performance of the transistor.	2
Lec8	Junction Field Effect Transistors JFET - basic structures, characteristics, parameters, static work, dynamic work with small signals, the frequency characteristics.	2
Lec9	Field effect transistors with insulated gate MOSFET - structure, types, characteristics, parameters. HexFET, VDMOS and IGBT transistors – basic information.	2
Lec10	Thyristor - construction, types, principle of operation, characteristics, two-transistor model and examples of applications to power control. Triac, Diac - construction, principle of operation, characteristics and applications.	2
Lec11	Optoelectronics - basic concepts, LEDs, photoresistors, photodiode, phototransistor, silicon photomultiplier, construction, principle of operation, characteristics, parameters, examples of applications.	2
Lec12	Photovoltaic panels - construction, operation, characteristics, parameters	2
Lec13	Electronic elements for protection and suppression – properties, basic parameters and characteristics.	1
Lec14	Operational amplifiers - basic structures, characteristics, parameters, static work, dynamic work with small signals, the frequency characteristics.	1
Lec15	Batteries, accumulators and sources of energy used in electronics – basic parameters and characteristics.	2
Lec16	Photovoltaic cells - practical applications.	2

Lec17	Introduction, requirements and forms of crediting. Instrumentation components. Sensors, signal conditioning blocks, analog-to-digital converters, interface circuitry. Tools and programming environments used in the design of classical and virtual instruments.	1
Lec18	Metrological properties of sensors (sensitivity, selectivity, linearity, repeatability, accuracy). Classification of sensors.	2
Lec19	Fundamentals and electronic instruments for measurement of position, displacement, and tension	1
Lec20	Fundamentals and electronic instruments for measurement of temperature.	2
Lec21	Fundamentals and electronic instruments for measurement of pressure.	2
Lec22	Fundamentals and electronic instruments for measurement of flow.	1
Lec23	Smart sensors.	1
Lec24	Sensor networks and interfaces.	1
Lec25	Serial interfaces.	2
Lec26	IEEE488 standard. SCPI specification.	1
Lec27	Network protocols used in distributed instrumentation.	1
	Total hours	**45**

Classes		**Number of hours**
Cl1	Organizational matters, conditions of gaining credit.	1
Cl2	Resistivity and resistance, calculation resistance of wirewound, carbon film, metal film and ceramic resistors, contacts, connections, cables etc. Capacitance and capacity – calculation of capacitance, charge/discharge curve and ESR coefficient. Calculation of air coils parameters, self-inductance and mutual.	2
Cl3	Ferrite core coil – properties, parameters calculation and design. Typical problems of impulse work. Transformer – properties, parameters and simple design calculations.	2
Cl4	Test I	1
Cl5	Semiconductor diodes – exercise in calculations of simple circuits. Power loss, thermal management and typical problems of impulse work.	1
Cl6	Bipolar junction transistor – small and large signal models, exercise in h-parameter calculation. Bipolar current sources and the current mirror. Bipolar transistor in amplifier and switching circuits. Calculation of switching and conduction losses of bipolar transistors.	2
Cl7	MOSFET transistor in amplifier and switching circuits. Calculation of switching and conduction losses of MOSFET transistors.	2
Cl8	Semiconductor switching elements – thyristor, triac, diac. Calculation of power loss in a switching and basic commutation circuit.	1
Cl9	Discrete optoelectronic components – photoresistor, photodiode, phototransistor. Calculation of its basic circuit and characteristic parameters.	1
Cl10	Test II	2
	Total hours	**15**

Laboratory		**Number of hours**
Lab1	Organizational matters. Introduction to LabView. Characteristics of laboratory stands.	2
Lab2	Dataflow model. Navigating LabVIEW. Loop, conditional and sequential structures.	2

Lab3	Parts of Virtual Instrument program: front panel, block diagram, icon and connection pane. Subroutines (subvi).	2
Lab4	Simple application that illustrates the principles of creating and running programs in LabVIEW.	2
Lab5	How to change front panel objects properties during program execution? Property nodes.	2
Lab6	Implementation of the “state machine” design pattern.	4
Lab7	VISA library and rules for its use to remotely control measurement instruments.	2
Lab8	Establishment of project teams. Overview and discussion of requirements.	2
Lab9	Implementation of the measurement experiment using GPIB instruments (work in two-person teams).	10
Lab10	Results presentation.	2
	Total hours	**30**

TEACHING TOOLS USED
N1. Standard lectures with multimedia presentations N2. Discussions on problems being solved N3. Performing experimental and programming classes N4. Individual consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 – PEU_W04	Final exam
F2	PEU_U01 – PEU_U02	Two tests, Graded assignments of laboratory tasks
P = 0.5*F1 + 0.5*F2 (positive grade under condition: F1≥3 & F2≥3)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] W. Gopel, J. Hesse, J.N. Zemel (Eds): Sensors. A Comrehensive Survey. VCH, Weinheim 1991.
[2] U.K. Mishra, J. Singh: Semiconductor Device Physics and Design, Springer-Verlag, Dordrecht 2008
[3] J.M. Pieper: Automatic Measurement Control: A Tutorial on SCPI and IEEE 488.2; Rohde & Schwarz GmbH, 2014.

SECONDARY LITERATURE:

[1] P. Hauptmann. Sensoren. Prinzipien und Anwendungen. Carl Hanser Verlag, Munchen1991.
[2] Hennel J., Podstawy elektroniki półprzewodnikowej, WNT, Warszawa 2003
[3] W. Tłaczała: Środowisko LabVIEW w eksperymencie wspomaganym komputerowo. Wydawnictwo Naukowo-Techniczne. Warszawa 2002.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Prof. Janusz Mroczka, Ph.D., D.Sc., janusz.mroczka@pwr.edu.pl

FACULTY ELECTRONIC

SUBJECT CARD

Name of subject in Polish:	**Fizyka dla elektroników**
Name of subject in English:	**Physics for Electronics**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00014**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	30			
Number of hours of total student workload (CNPS)	90	90			
Form of crediting	crediting with grade	crediting with grade			
For group of courses mark (X) final course	**x**				
Number of ECTS points	**6**				
including number of ECTS points for practical (P) classes		3			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1	1			

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Differential and integral calculus of one variable, the basics of differential and integral calculus of several variables, vectors in the plane and space complex numbers..

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SUBJECT OBJECTIVES

C1 Gaining additional knowledge of mathematics necessary to understand the laws of electromagnetism,

C2 Understanding the laws and physical mechanisms of electric and magnetic fields in vacuum and in materials.

C3 Knowledge of the value of physical constants describing the phenomena's of electromagnetism in materials.

C4 Gaining knowledge of a plane wave, wave propagation in various mediums, and the laws governing the phenomena of reflection and refraction of electromagnetic waves.

C5 Obtaining knowledge about the practical aspects of electromagnetism important in engineering practice.

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01 – knows the basic operational calculus

PEU_W02 - knows the laws and phenomena of the electriostatic field

PEU_W03 - knows the laws and phenomena of the steady magnetic field and the Maxwell equations

PEU_W04 - knows the parameters and structure of a plane wave, reflection and refraction of a plane wave

PEU_W05 - understanding the practical aspects of electromagnetic phenomena relevant to engineering practice.

relating to skills:

PEU_U01 - can use the laws of electromagnetism to explain aspects of engineering practice

PEU_U02 - can use basic formulas to calculate the field distribution, resistance, capacitance and inductance of physical objects

PEU_U03 - is able to recognize and define the physical phenomena associated with electromagnetism.

relating to social competences:

PROGRAMME CONTENT

Form of classes - lecture		**Number of hours**
Lec1	Vector algebra, coordinate systems, vector calculus– review.	2
Lec2- Lec5	Electrostatic field; Coulmb,s law, Gauss's law,	8
Lec6 - Lec7	The current; Ohm law, Poisson's and Laplace,, resistivity	4
Lec8 - Lec9	Magnetic field; Biot-Savart' law, Amper's law, Faraday's law; forces in magnetic field, inductance, transformer.	4
Lec10 - Lec11	Elements of electrodynamic; Maxwell equasions, dipol, plane wave,	4
Lec12 - Lec14	Electromagnetic wave propagation, waveguides, reflection and refraction	6
Lec15	Resume	2
	Total hours	**30**

Classes		**Number of hours**
Cl1 – Cl5	Calculation of electric field and potential distribution	10
Cl6 - Cl7	Calculation of capacitance and resistance of the objects	4
Cl8 – Cl10	Calculation of magnetic field distribution and inductance	6
Cl11 – Cl14	Calculation of electromagnetic wave parameters, reflection and refraction	8
Cl15	Resume	2
	Total hours	**30**

TEACHING TOOLS USED

N1. Chalkboard - clarification of the lows in the form of drawings,

N2. Practical demonstrations of technical elements associated with electromagnetism

N3. Consultation,

N4 Self-studies of issues described during lectures..

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 – PEU_W05	Final test
F2	PEU_U01 – PEU_U03	Quizzes and/or final test
C=0.51*F1 + 0.49*F2; F1 and F2 must be positive		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] M. N. O. Sadiku, Elements of Electromagnetics, Oxford Press, 3rd edition, 2001.
[2] E. M. Purcell, Electrcity and Magnetizem, McGraw Hill.

SECONDARY LITERATURE:

[3] J. Witkowski: Jak rozwiązywać zadania z elektromagnetyzmu -skrypt
[4] W. Michalski: Elektryczność i magnetyzm, zbiór zagadnień i zadań cz.1, 2, 3, Oficyna Wydawnicza Politechniki Wrocławskiej, 2009
[5] M. Karkowski: Elektrotechnika teoretyczna cz. 2, Wydawnictwo Naukowe PWN, 1995
[6] W. Michalski, R. Nowicki – Zbiór zagadnień i zadań z teorii pola, elektromagnetycznego, , Oficyna Wydawnicza Politechniki Wrocławskiej, 1995
[7] D.J. Griffiths ; Podstawy elektrodynamiki, Wydawnictwo Naukowe PWN, 2005

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Dr inż. Janusz Rzepka, janusz.rzepka@pwr.wroc.pl

Zał. nr 5 do ZW 16/2020

FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Podstawy automatyki**
Name of subject in English:	**Introduction to Automatic**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00019**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		15		
Number of hours of total student workload (CNPS)	30		60		
Form of crediting	Crediting with grade		Crediting with grade		
For group of courses mark (X) final course	**X**				
Number of ECTS points	**3**				
including number of ECTS points for practical (P) classes			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1		1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

C1 Acquisition of knowledge of basic concepts of control theory and systems theory.
C2 Knowledge how to perform simple simulations in MATLAB/Simulink.
C3 Acquisition of knowledge of principles of operation and tuning controllers, sensors, actuators, and industrial controllers, computer networks and automatic signal standards.
C4 Acquisition of knowledge on identification, mathematical model, computer simulation, dynamics design of closed-loop system.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 knows definitions and basic properties of static and dynamic systems, linear and non-linear systems.

PEU_W02 knows a basic structure of control systems and linear regulators.

PEU_W03 has a basic knowledge of mathematical models of control engineering objects, methods for identifying and computer simulation

PEU_W04 has a basic knowledge of selection of controls and settings of regulators, sensors, industrial controllers, and actuators.

relating to skills:

PEU_U01 is able to plan and conduct an experiment to determine the dynamics of the controlled object.

PEU_U02 can run a simple simulation of linear dynamic systems in MATLAB / Simulink.

PEU_U03 can run a simple test for automatic control systems in MATLAB / Simulink.

relating to social competences:

PEU_K01 Students are aware of necessity to search and collect technical information permanently and to analyze the data critically.

PEU_K02 Students understand and can apply the principles of health and safety at work with devices of automation in the laboratory and beyond.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec1	The basic structure of control systems and linear regulators, industrial controllers, sensors, actuators.	2
Lec2	Static and dynamic, linear and nonlinear, stationary and non-stationary systems. Impulse response and step response. Frequency domain characteristics	2
Lec3	Selected properties of systems, stability and instability of systems.	2
Lec4	Automatic regulation. Regulation systems in open and closed-loop. Some elementary properties of linear regulators. Tuning PID controllers	2
Lec5	Introduction and presentation of the overall structure of master SCADA system.	1
	Sensors and different methods of measuring basic physical phenomena	1
Lec6	Sensors and different methods of directly and indirectly measuring	1
	Standards and signals of measurement	1
Lec7	Measurement converters and other devices to convert signals of measurement	1
	Methods of power supply and protecting of measuring and executive devices, methods and symbols used in electric designs	1
Lec8	Actuators	2
Lec9	Norms and standards used on technological schema of industrial processes	1
	Devices used as central measurement stations. The function of PLC controller in a distributed control system.	1

Lec10	Construction and configuration of PLC controller. Methods of programming PLC controllers	2
Lec11	A basic structure and rules of ladder language. The memory structure and types of values in PLC controllers	2
Lec12	Microprocessor PID controllers: - structures of hardware, discrete equation of regulator, multi-function and modular controllers	1
	Controllers tuning in control systems.	1
Lec13	Two- and three-state controllers. Fuzzy controllers.	2
Lec14	Serial communication standards used in systems of acquisition of measuring data	2
Lec15	SCADA systems and operator panels in distributed control systems.	2
	Total hours	30

Laboratory		**Number of hours**
Lab 1	Training of health and safety-at-work legislation. Organizational details. Basics of Matlab/Simulink.	3
Lab 2	Simulation of linear and nonlinear objects	3
Lab 3	Impulse response and step response. Frequency domain characteristics	3
Lab 4	PID regulator with different linear objects. Tuning PID controllers	3
Lab 5	Linear controller with nonlinear object	3
	Total hours	15

TEACHING TOOLS USED
N1. Traditional lecture using video projector N2. Laboratory classes N3. Consultations. N4. Independent work – preparation for laboratory classes. N5. Independent work – self study.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 - PEU_W04	written test
F2	PEU_U01 - PEU_U03 PEU_K01 – PEU_K02	evaluation of laboratory reports
P = 0,5*F1 + 0,5*F2 (in order to pass the course, both F1 and F2 must be positive)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Bolton W.: *Programmable Logic Controllers*, Elsevier 2003

[2] Fraden J.: *Handbook of Modern Sensors, Physics, Designs, and Applications,* AIP Press

& Springer, New York 2003
[3] Łysakowska B., Mzyk G. *Komputerowa symulacja układów automatycznej regulacji w środowisku MATLAB/Simulink*, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 2005.

SECONDARY LITERATURE:

[1] lecture notes
[2] internet resources

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Zbigniew Zajda, zbigniew.zajda@pwr.edu.pl

Faculty of Electronics (W4) / Department of Field Theory, Electronic Circuits and Optoelectronics (K35W04D02)

SUBJECT CARD

Name of subject in Polish: **Wprowadzenie do mikrokontrolerów**

Name of subject in English: **Introduction to microcontrollers**

Main field of study (if applicable): **Electronic and Computer Engineering (ECE)**

Profile: **academic**

Level and form of studies: **1st level, full-time**

Kind of subject: **obligatory**

Subject code: **ECEA00022**

Group of courses: **Yes**

	Lecture	Exercise	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	15	45		
Number of hours of total student workload (CNPS)	60	60	120		
Form of crediting	Examination	Crediting with grade	Crediting with grade		
For group of courses mark (X) the final course	X				
Number of ECTS points	8.0				
including number of ECTS points for practical (P) classes		2.0	4.0		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.0	1.0	3.0		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

C1. Gaining basic knowledge of the design of microprocessor systems

C2. Gaining basic knowledge on basic peripherals implemented in the structures of microcontrollers

C3. Gaining basic knowledge of software development on the chosen hardware platform

C4. Acquiring the ability to run applications and its testing in the microprocessor system

SUBJECT LEARNING OUTCOMES
Relating to knowledge: PEU_W01 - knows the rules of operation of the microprocessor PEU_W02 - have knowledge about the main elements of the architecture of the microprocessor PEU_W03 - knows what are the basic elements of microprocessors PEU_W04 - knows the principles for the design of electrical circuits containing microprocessors Relating to skills: PEU_U01 - is able to program microprocessors and microcontrollers in machine language PEU_U02 - is able to program the microprocessors and microcontrollers in a high level language PEU_U03 - is able to develop algorithms and implement them for the selected platform PEU_U04 - is able to take advantage of the major functional blocks of microprocessors

PROGRAM CONTENT		
Lecture		**Number of hours**
Lec1, 2	The basic structure of logical operators and a description using the logic equations, representation of data, number systems	4
Lec3	Introduction to programmable logic structures used in the design process of electronic devices	2
Lec4	Introduction to computer architecture. The implementation of the code and processor architecture	2
Lec5	Processor architecture, flow control. The role of the arithmetic logic unit and an instruction decoder in the microprocessor	2
Lec6, 7	Assembler for the sample platform. Addressing modes of processor systems. The process of compiling, linking and code testing	4
Lec8	The use of high-level languages in the software development process	2
Lec9	Test	2
Lec10	Architecture microcontrollers. Address space, bus, memory types	2
Lec11	The importance of electrical parameters. Power supplies of microprocessors. Sources of resetting and of clocking in the microprocessor systems	2
Lec12	Interrupt system and its importance in microprocessor systems	2
Lec13	The role and implementation of peripheral circuits in the microcontrollers. General-purpose I/O ports and timers	2
Lec14	Overview simple serial buses - SPI, UART	2
Lec15	ADC and DAC in microprocessor systems	2
	Total hours:	30

Exercise		**Number of hours**
Ex1	Introduction to the course. Binary arithmetics.	3
Ex2	Basic logic.	2
Ex3	Logic optimisation	2
Ex4	Design of combinational circuits	2
Ex5, 6	Design of sequential circuits	4
Ex7	Microprocesor	2
	Total hours:	15

Laboratory		Number of hours
Lab1, 2	Introduction to the architecture of the chosen platform and presentation of development environment. The use of assembler and simulator software development process.	6
Lab3	The exchange of data, simple arithmetic and logical operations and control program.	3
Lab4	The use of general purpose ports for the implementation of the interface with the user.	3
Lab5, 6	The use of interrupts in software development for microprocessors. Timers and counters	6
Lab7, 8	The use of synchronous serial bus for communication with external peripheral circuits.	6
Lab9, 10	The use of high-level language to develop software for microprocessors.	6
Lab11, 12	The use of analog-to-digital and digital-to-analog subsystems for measurement and control processes.	6
Lab13, 14	The use of asynchronous serial bus for communication with another module or a PC.	6
Lab15	End test	3
	Total hours:	45

TEACHING TOOLS USED
N1. Lectures using multimedia presentations and whiteboard.
N2. Laboratory classes - discussions on solutions applied.
N3. Class Project - problems discussion
N4. Consultations
N5. Self education

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation: F — forming (during semester), C — concluding (at semester end)	Learning outcome code	Way of evaluating learning outcome achievement
1	PEK_W01-04	Final exam
2	PEK_U01-04	Tests and report laboratory exercises
3	PEK_U01-04	Presentations and implementation of the project
P = 0.5*F1+0.25*F2+0.25*F3, (positive grade under condition: F1>2 i F2>2 i F3>2)		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE:
[1] [1] N. Senthil Kumar, et al., Microprocessors and Microcontrollers, Oxford University Press 2010, ISBN 0198066473
[2] [2] D. Harris, S. Harris, Digital Design and Computer Architecture, Elsevier, 2012, ISBN 0123978165
[3] [3] J. Bear, Microprocessor Architecture, Cambridge University Press, 2009 ISBN 0521769921
[4] [4] W. Smith, C Programming for Embedded Microcontrollers, Elektor 2009, ISBN 0905705804
SECONDARY LITERATURE:
[1] A. Pal, Microcontrollers, Principles and Applications, ISBN: 8120343924

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Grzegorz Budzyń, grzegorz.budzyn@pwr.edu.pl

FACULTY OF ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Podstawy telekomunikacji**
Name of subject in English:	**Fundamentals of Telecommunications**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00021**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	60		60		
Form of crediting	credit with grade		credit with grade		
For group of courses mark (X) final course	**x**				
Number of ECTS points	**4**				
including number of ECTS points for practical (P) classes			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1		1		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1 Obtaining the knowledge on fundamental principles of telecommunication
C2 Gaining basic skills on the analysis and assessment of telecommunication signals

SUBJECT LEARNING OUTCOMES

I. Relating to knowledge: has basic knowledge of telecommunications

PEU_W01 – knows basics of signal representation in time and frequency domain.
PEU_W02 – knows basics of notions used in the description of telecommunication systems.
PEU_W03 – knows basics of analogue and digital modulations.
PEU_W04 – knows the theorem on the bandwidth of telecommunication channel and principles of wideband systems.
PEU_W05 – knows and understands telecommunication systems architecture.
PEU_W06 – knows the telecommunication system parameters.

Relating to skills:

PEU_U01 – is able to set and operate the spectrum analyzer, PEU_U02 – is able to measure primary parameters of an analogue-modulated and a digitally-modulated signals, PEU_U03 – is able to assess the influence of interference on transmission parameters of communication systems

PROGRAMME CONTENT		
Lecture		**Number of hours**
Lec 1	Introduction. The purpose and role of telecommunications. Standardization and legal aspects.	2
Lec 2	The concept of telecommunication system, modulations.	2
Lec 3	The source and channel coding, multiple access techniques	2
Lec 4	Basics of information theory, signals in time and frequency domain.	2
Lec 5	The communication channel, entropy and redundancy	2
Lec 6	Radio systems, interference and noise	2
Lec 7	Antennas and link budget	2
Lec 8	Radio propagation	2
Lec 9	Optical fibers and waveguides	3
Lec 10	Cellular networks (2G – 5G)	2
Lec 11	Satellite networks	2
Lec 12	High frequency circuits	2
Lec 13	Wireless networks, RFID, interaction of radio signals with human body	3
Lec 14	Revision	2
	Total hours	**30**

Laboratory		**Number of hours**
Lab 1	Introduction. Getting acquainted with laboratory equipment. Spectrum analyzer, bandwidth, signal to noise ratio	3
Lab 2	Analogue modulations – AM	3
Lab 3	Analogue modulations – FM	3
Lab 4	Analogue modulations – PM	3
Lab 5	Digital modulations – ASK/ FSK	3
Lab 6	Digital modulations – PSK/ CDMA	3
Lab 7	Analysis of interference influence on transmission parameters of communication systems	3
Lab 9	Optical communication – fibers and passive fibers components	3
Lab 8	Optical communication – transmission through the fibers	3
Lab 10	Final test.	3
	Total hours	30

TEACHING TOOLS USED
N1. Traditional lectures using multimedia presentations N2. Supervised laboratory activities N3. Consultation N4. Self study

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 - PEU_W06	written or electronic test
F2	PEU_U01 - PEU_U03	written test, reports
P = 0,6*F1+0,4*F2 a positive concluding grade is conditioned by obtaining positive grades of all forms of classes included in the subject		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Simon Haykin, *Communication Systems,* Wiley, May 2009, ©2010
[2] Tommy Öberg, *Modulation, detection and coding*, John Wiley & Sons, Chichester 2001.
[3] Jerry D. Gibson, *Principles of digital and analog communications*, MacMillan Publ., New York, 1993.
[4] Chakrabarti, P., *Optical Fiber Communication*. McGraw-Hill Education, 2015.

SECONDARY LITERATURE IN POLISH:

[1] W. David Gregg, *Podstawy telekomunikacji analogowej i cyfrowej*, Wydawnictwa Naukowo-Techniczne, Warszawa 1983.
[2] Daniel Józef Bem, *Systemy telekomunikacyjne. Cz. 1, Modulacja, systemy wielokrotne, szumy*. Politechnika Wrocławska, Wrocław 1978.
[3] Zieliński, T. P., *Cyfrowe przetwarzanie sygnałów: od teorii do zastosowań*. Wydawnictwa Komunikacji Łączności, 2005.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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Dr hab. inż. Jarosław Sotor, Jarosław.sotor@pwr.edu.pl

Zał. nr 5 do ZW 16/2020

FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Podstawy robotyki**
Name of subject in English:	**Introduction to Robotics**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00020**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		15		
Number of hours of total student workload (CNPS)	30		60		
Form of crediting	Crediting with grade		Crediting with grade		
For group of courses mark (X) final course	**X**				
Number of ECTS points	**3**				
including number of ECTS points for practical (P) classes			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1		1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

C1 Knowledge of robotic terminology and basic tasks of robotics.
C2 Acquisition of knowledge on modeling robots and their environment and basic techniques used to solve tasks of kinematics and motion planning for the robots
C3 Developing skills to implement, test and analyze selected robotic algorithms for manipulators and mobile robots.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 can classify robots according to different criteria.

PEU_W02 are able to formulate algorithms for forward and inverse kinematics and dynamics.

PEU_W03 can characterize sensors of robotics.

PEU_W04 knows basic methods of motion planning for mobile robots and interpolation techniques for manipulators.

PEU_W05 – acquires knowledge on modeling robots and their environment.

relating to skills:

PEU_U01 can define basic robotic tasks and discuss their ingredients.

PEU_U02 are able to calculate kinematic tasks for manipulators and mobile robots.

PEU_U03 can simulate a motion of selected mobile robots.

PEU_U04 are able to select purposefully parameters for basic interpolation and motion planning tasks.

relating to social competences:

PEU_K01 Students are aware of necessity to search and collect technical information permanently and to analyze the data critically.

PEU_K02 Students understand and can apply the principles of health and safety at work with devices of robotics in the laboratory and beyond.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec1-2	Terminology, an overview, and classifications of robotic tasks.	4
Lec3-4	Coordinate frame transformations and their compositions. Uniform coordinates.	4
Lec5-6	Forward and inverse kinematics for manipulators.	4
Lec7-8	Kinematics of mobile robots: from constraints to driftless systems.	4
Lec9	Jacobian and Newton algorithm for manipulators.	2
Lec10	Forward and inverse task of robot dynamics.	2
Lec11	Sensors of robotics: modeling obstacles and a robot itself.	2
Lec12	Interpolation methods of motion planning for manipulators.	2
Lec13	Methods of motion planning for mobile robots.	2
Lec14	Action planning for robots.	2
Lec15	Summary of lectures.	2
	Total hours	30

Laboratory		**Number of hours**
Lab1	Transformations of coordinate frames.	3
Lab2	Forward kinematics.	3
Lab3	Inverse kinematics.	3

Lab4	Modelling mobile robots.	3
Lab5	Dynamics and control.	3
	Total hours	15

TEACHING TOOLS USED
N1. Traditional lecture using video projector N2. Laboratory classes N3. Consultations. N4. Independent work – preparation for laboratory classes. N5. Independent work – self study.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating learning outcomes achievement
F1	PEU_W01 – PEU_W05	written test
F2	PEU_U01 – PEU_U04, PEU_K01 – PEU_K02	evaluation of laboratory reports
P = 0,5*F1 + 0,5*F2 (in order to pass the course, both F1 and F2 must be positive)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] M. Spong, M. Vidyasagar, *Dynamics and robot control*, WNT, 1997
[2] J.J. Craig, „*Introduction to robotics*", WNT, 1995.
[3] P.J. McKerrow, *Introduction to robotics*, Adisson-Wesley Publ, 1991

SECONDARY LITERATURE:

[1] lecture notes
[2] internet resources
[3] S. LaValle, Planning Algorithms, Cambridge Univ. Press., 2006

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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Faculty of Electronics (W4) / Department of Field Theory, Electronic Circuits and Optoelectronics (K35W04D02)

SUBJECT CARD

Name of subject in Polish: **Python**

Name of subject in English: **Python**

Main field of study (if applicable): **Electronic and Computer Engineering (ECE)**

Profile: **academic**

Level and form of studies: **1st level, full-time**

Kind of subject: **obligatory**

Subject code: **ECEA00025**

Group of courses: **Yes**

	Lecture	Exercise	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		15		
Number of hours of total student workload (CNPS)	30		30		
Form of crediting	Crediting with grade		Crediting with grade		
For group of courses mark (X) the final course	X				
Number of ECTS points	3.0				
including number of ECTS points for practical (P) classes			2.0		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0.5		1.5		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. The student knows the basis of programming, and its methodology.

SUBJECT OBJECTIVES

C1. Learning the basics of practical programming in the Python language.

C2. Ability to communicate with external devices.

SUBJECT LEARNING OUTCOMES

Relating to knowledge:

PEU_W01 - The student has a basic knowledge of the Python programming.

PEU_W02 - The student has knowledge of popular protocols for communicating with external devices.

Relating to skills:

PEU_U01 - Writing the Python programs.
PEU_U02 - Ability to communicate with external devices.

PROGRAM CONTENT		
Lecture		**Number of hours**
Lec1	Variables and data types. Conditional instructions, loops and strings.	3
Lec2	Lists, tuples, dictionaries, sets, exceptions, functions, modules, and classes.	2
Lec3	Using text files, JSON processing, and XML processing.	2
Lec4	Using libraries and file operations for data processing.	2
Lec5	Remote data, use of web services, and use of databases.	2
Lec6	Practical use of Python to communicate with measuring devices and smart home devices.	2
Lec7	Exam.	2
	Total hours:	15

Laboratory		**Number of hours**
Lab1	Environment preparation. Hello World.	3
Lab2	Console programs. Standard input/output, mathematical and conditional operations.	3
Lab3	Signals processing from text files.	3
Lab4	Net services.	3
Lab5	Communication with measurement devices.	3
	Total hours:	15

TEACHING TOOLS USED
N1. Lecture with using blackboard and LCD projector.
N2. Laboratories with computers, materials on course website.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation: F — forming (during semester), C — concluding (at semester end)	Learning outcome code	Way of evaluating learning outcome achievement
F1	PEU_W01-W02	Grade from exam.
F2	PEU_U01-W02	Evaluation based on laboratory reports.
P = 0.5*F1 + 0.5*F2 (in order to pass the course, both F1 and F2 must be positive)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Mark Lutz, Learning Python, ISBN-13: 978-1449355739, ISBN-10: 1449355730
[2] Allen Downey, Think Python How to Think Like a Computer Scientist, Green Tea Press Needham, Massachusetts, ISBN-13: 978-1491939369, ISBN-10: 1491939362

SECONDARY LITERATURE:

[1] Luciano Ramalho, Fluent Python: Clear, Concise, and Effective Programming, O'Reilly Media Inc, USA, ISBN-13: 978-1491946008, ISBN-10: 1491946008

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Arkadiusz Hudzikowski, arkadiusz.hudzikowski@pwr.edu.pl

Zał. nr 5 do ZW 16/2020

FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Cyfrowe przetwarzanie sygnałów**
Name of subject in English:	**Digital Signal Processing**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00102**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		45		
Number of hours of total student workload (CNPS)	90		120		
Form of crediting	credit with grade		credit with grade		
For group of courses mark (X) final course	**X**				
Number of ECTS points	**7**				
including number of ECTS points for practical (P) classes			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,5		2,5		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Introduction to Microcontrollers - knows basic architectures of 8-, 16-, 32 bits microcontrollers
2. Object oriented programming - Is able to write, debug and evaluate program for control of selected microcontroller and its peripherals with the use of software tools.

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SUBJECT OBJECTIVES

C1 Better understanding the principles of signal processing mainly digital signal processing

C2 Acquiring skills in applying abstract mathematical concepts to processing of real signals.

C3 Acquiring of the knowledge about the architecture and work of DSP processors and structures

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 – knows problems of signal representation, understands sampling and quantization problem.

PEU_W02 – knows basic problems and rules of digital signal processing theory

PEU_W03 –knows basic structures of digital filters and implementation rules

PEU_W04 –knows architectures and work of effective signal processing structures, with special attention to DSP processors.

PEU_W05 –knows tools and methods for code generation and debugging in real time DSP processors.

relating to skills:

PEU_U01 – Is able to make basic analysis of signal in time and frequency domain including preparation and use digital filters

PEU_U02 – can use development tools starting from the installation, configuration up to debugging of program.

PEU_U03 – Is able to develop programs for basic signal processing algorithms for implementation on DSP taking into account specific of used language (C, ASM) and H&W feature of the processor.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec1	Discrete sequences and systems. Signals representation, Sampling theorem	2
Lec2	DFT - Discrete Fourier Transform, accompanying effects, Computation algorithm, Circular convolution and block processing	2
Lec3	FFT - Fast Fourier Transform Radix-2 FFT Computation algorithms, Butterfly structures	2
Lec4	Finite Impulse Response Filters (FIR), Characteristic of linear phase FIR filters, Phase response	2
Lec5	Infinite Impulse Response Filters (IIR), Causal and anticausal filterring	2
Lec6	Digital filter implementation considerations, Zero phase filtering, Number representation and arithmetic schemes, Quantization and overflow operations	2
Lec7	Quadrature Signals, Discrete Hilbert transform	2
Lec8	Multirate processing, Signal averaging, selected tricks examples	2
Lec9	Signal as stochastic process representation, basic parameters and higher order statistics,	2
Lec10	Nonstationary, stationary, and ergodic Random processes, Influence of linear system on a stochastic process	2
Lec11	Introduction to estimation theory, Estimation methods and errors, Estimator classes. Spectrum estimation	2
Lec12	Digital Signal Processors - Integrated structures for Digital Signal Processing - basic architectures	2

Lec13	Getting started with DSP, Fixed versus Floating point, C versus Assembly language	2
Lec14	World offer of DSP structures. DSP processors as a part of embedded world.	2
Lec15	Rapid design and prototyping of DSP systems, Starter kits and evaluation modules, Support importance, Development environment.	2
	Total hours	**30**

Laboratory		**Number of hours**
Lab1	Overview of the program and the organization of the laboratory classes. Workplace training in health and safety. Signal processing basic path structure-laboratory module recognition	3
Lab2	TMS320C5015 processor architecture and features. Module driving from the host PC	3
Lab3	Code Composer Studio fundamentals, what is offering and how to use it. Tools of effective control over DSP running in real time - sampling effect observation	3
Lab4	Similarities and differences inview of DSP effects in CCS and Matlab - basic discrete time signal observation and features, test signals generation	3
Lab5	Calculation of the DFT from the Definition, Goertzel's Algorithm,	3
Lab6	FFT computation and use, Coley-Tukey FFT, Recursive Derivation of the FFT, Split-Radix FFT, Evaluation of the Matlab FFT	3
Lab7	Discrete-Time filter Design-1, Discrete design of FIR filters and its evaluation	3
Lab8	Discrete-Time filter Design-2, Discrete design of IIR filters and its evaluation	3
Lab9	Spectrum analysis, Spectral windows (types, performance, resolution), Spectrogram	3
Lab10	Multirate processing, Band limited interpolation, Zoom transform, Rate changing	3
Lab11	Stochastic signals, Random variables, Nonstationary, stationary, and ergodic random process, Influence of linear system to a stochastic process	3
Lab12	Implementation of designed earlier and evaluated FIR filter on the DSP processor module, Result comparison	3
Lab13	Implementation of designed earlier and evaluated IIR filter on the DSP processor module, Result comparisons	3
Lab14	Real time spectrum analysis using DSP processor on the evaluation module	3
Lab15	Real time spectrum analysis using DSP processor on the evaluation module	3
	Total hours	**45**

TEACHING TOOLS USED
N1. Lecture supported with slides
N2. WEB-Page with literature, illustration lecture slides and producers documentation
N3. Course problem WIKI-s
N4. Consultation
N5. Self-preparation for the laboratory classes checked with entrance test
N6. Experiments in laboratory closed with report
N7. Individual studies of technical documentation from silicon producers.
N8. Individual preparation for the final qualification test

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation {F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating educational effect achievement
F1	PEU_W01 – PEU_W05	test
F2	PEU_U01 – PEU_U03	Laboratory (Preparation for the laboratory, tools recognition and use, work and result of work with technical documentation studies, Lab entrance tests result and final reports)
P = 0,7*F1 + 0.3*F2 (required F>2.0)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] R.G. Lyons; "*Understanding Digital Signal Processing"* ; Pearson Education Inc. 2004

[2] Sen M. Kuo, Bob H. Lee, Wenshun Tian; *"Real-Time Digital Signal Processing: Implementations and Applications"*, 2nd Edition, Wiley 2006

SECONDARY LITERATURE:

[1] A. V. Oppenheim and W. Schafer.; "*Discrete-Time Signal Processing*", Prentice Hall 2002.

[2] Steven W. Smith; *"Digital Signal Processing and: A practical Guide for Engineers and Scientists."; Elsevier 2003*

[3] C. S. Burrus a.o.; *"Computer Based Exercises for Signal Processing Using Matlab"*

[4] V. K. Madisetti, ; *'Digital Signal Processing Handbook -Fundamentals"; CRC Press 2010*

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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Zał. nr 5 do ZW 16/2020

FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Sieci komputerowe**
Name of subject in English:	**Computer Networks**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00101**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	60		60		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course	**X**				
Number of ECTS points	**4**				
including number of ECTS points for practical (P) classes			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1		1		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1 To gain basic knowledge in the field of computer networks including applications and role in the modern world, technologies and protocols

C2 To gain practical knowledge and skills in construction, design and configuration of computer networks, analyzing of network traffic

C3 To gain and enforce social competences including the idea of normalization and certification in the field of computer networks

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 The course results with a student's ability to explain and describe basic information in the field of computer networks including applications and role in the modern world

PEU_W02 The course results with a student's ability to explain and describe basic standards of computer networks including cables, technologies and protocols

PEU_W03 The course results with a student's ability to explain and describe basic information related to design and configuration of computer networks

relating to skills:

PEU_U01 The course results with a student's ability to construct and configure a simple computer network including design of IP addressing, to use diagnostic tools

PEU_U02 The course results with a student's ability to use a network protocol analyzer

PEU_U03 The course results with a student's ability to configure and manage popular network services

PROGRAMME CONTENT

Lecture		**Number of**
Lec 1	Introduction to computer networks	2
Lec 2	Protocols and layers	2
Lec 3	TCP/IP layered model	2
Lec 4	IPv4 Addressing	2
Lec 5	Medium Access Control (MAC)	2
Lec 6	Ethernet and Switching	2
Lec 7	Internet Protocol	2
Lec 8	Subnetting and routing	2
Lec 9	Transport Layer3	3
Lec 10	Application Layer3	3
Lec 11	Physical Layer and Transmission Media	2
Lec 12	Virtual LANs	2
Lec 13	Network security essentials	2
Lec 14	Review of examination issues	2
	Total hours	**30**

Laboratory		**Number of hours**
Lab 1	Organizational information, rules of laboratory, rules of grading. Presentation of laboratory tools.	2
Lab 2	Connecting devices into computer network. Checking the correctness of network operation. diagnostic tools.	2
Lab 3	Application-layer network services (http, ftp, dns), domain name system and address translation process.	2
Lab 4	Analysis of header structure and operation of transport-layer protocols – using network analyzer. Identification and analysis of transport-layer sessions – at workstation level.	2

Lab 5	Analysis of header structure and operation of network-layer protocols using network analyzer. Addressing schemes in computer networks. Diagnostics of networks. Basis of path determining (routing) in computer networks. Remote work with remote terminal protocol.	4
Lab 6	Analysis of header structure and operation of data-link-layer protocols using network analyzer. Addressing rules at data link layer.	2
Lab 7	Ethernet technology, switching rules in Ethernet networks. Address resolution protocol.	2
Lab 8	Implementation of computer networks using switches and routers. Basic configuration of network devices.	2
Lab 9	Implementation of computer networks and configuration of network devices in network simulator. Simulation and correctness verification of network operation.	2
Lab 10	Implementation of computer networks and configuration of network devices. Correctness verification of network operation, solving typical configuration problems.	4
Lab 11	Individual practical assignment – implementing of small computer network	4
Lab 12	Review: network architectures, roles and protocols of network layers, communication rules in computer network.	2
	Total hours	**30**

TEACHING TOOLS USED

N1. Lecture with multimedia presentations.
N2. Problem-oriented lecture
N3. Discussion
N4. Practical tasks in laboratory
N5. Tests on e-learning platform
N6. Consultation
N7. Own work – preparation to lecture, laboratory.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 – PEU_W03	Test, oral exam
F2	PEU_U01 – PEU_U03	Test, evaluation of labaratory tasks, reports, e-learning tests
P = 0,5 ∗F1 + 0,5∗F2, concluding grade may be passive subject to F1 and F2 are passive		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Tannenbaum A., S., Computer Networks, Prentice Hall 5th edition, 2010
[2] Kurose J., Ross K., Computer Networking: A Top-Down Approach, Pearson, 2016
[3] West J., Andrews J., Dean T., Network+ Guide to Networks, Course Technology, 2018
[4] Cisco netacad.com materials

SECONDARY LITERATURE:

[1] RFC (ang. Request for Comments) standards www.ietf.org
[2] IEEE (ang. Institute of Electrical and Electronics Engineers) standards www.ieee.org
[3] Networld Journal
[4] Materials of computer network devices and software vendors

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Dr inż. Michał Kucharzak, michal.kucharzak@pwr.edu.pl

Faculty of Electronics (W4) / Department of Field Theory, Electronic Circuits and Optoelectronics (K35W04D02)

SUBJECT CARD

Name of subject in Polish: **Projekt zespołowy i przedinżynierski**

Name of subject in English: **Team and preeingineering project**

Main field of study (if applicable): **Electronic and Computer Engineering (ECE)**

Profile: **academic**

Level and form of studies: **1st level, full-time**

Kind of subject: **obligatory**

Subject code: **ECEA00106**

Group of courses: **No**

	Lecture	Exercise	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)				75	
Number of hours of total student workload (CNPS)				150	
Form of crediting				Crediting with grade	
For group of courses mark (X) the final course				X	
Number of ECTS points				5.0	
including number of ECTS points for practical (P) classes				5.0	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				5.0	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

C1. Acquiring the ability to carry out their engineering tasks as part of a complex engineering task

C2. Gain experience in teamwork, including the ability to planning and scheduling, intra-team communication, perform the role of a team member or leader, the opportunity to demonstrate their creativity, openness to innovative approaches focused on the team's success

SUBJECT LEARNING OUTCOMES

Relating to skills:

PEU_U01 - is able to perform tasks in the implementation of an electronic or automation & robotics or IT or mixed project

PEU_U02 - is able to prepare the project's documentation

Relating to social competences:

PEU_K01 - can work with the team, has a consciousness of their role in the project and attention to the timely execution of the tasks assigned

PROGRAM CONTENT

Project		Number of hours
Pr1	Determining the subject and purpose of the project (eg., web information system, a complex system database, a comprehensive project of computerization), the allocationm of roles in the project, the initial allocation of tasks to be performed, the choice of team leader	4
Pr2	Introduction to the problem area of the project. Overview of solutions in the area of the problem - an analysis of the methods and applied information technology.	4
Pr3	Analysis of user requirements, including an analysis of the economic impact of the project implementation. Development of project assumptions. Determining the initial timetable for action (in the form of Gantt chart) and the principles of intra-team and teacher communication	8
Pr4	Analysis of risks in the project, establish emergency scenarios and ways to monitor risks. Planning for quality management principles in the project, development of quality control procedures. Establish rules for the results subsequent stages justification of a project and rules for documenting the stages	4
Pr5	The implementation of individual project tasks according to the schedule of the first stage of the project	12
Pr6	The implementation team meetings with the teacher - in accordance with the agreed schedule (milestone)	4
Pr7	The implementation of individual project tasks by scheduling the second stage of the project	12
Pr8	Presentation of the results of the executed project, discuss problems, the assessment of the completed project by the teacher. Verification of the project. Determination of possible changes	8
Pr9	Presentation of final project documentation in writing form	4
	Total hours:	60

TEACHING TOOLS USED

N1. Multimedia presentation

N2. Discussion

N3. Consultation

N4. Own work

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation: F — forming (during semester), C — concluding (at semester end)	Learning outcome code	Way of evaluating learning outcome achievement
F1	PEU_U01, PEU_K01	Rating presenting subsequent stages of the project and team skills: the timetable, the activity of the team, the ability to apply the principles of project management
F2	PEU_U02	Evaluation of the quality of the executed project and design documentation
P = 0.4*F1 + 0.6*F2 (in order to pass the course, both F1 and F2 must be positive)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Collective work, A Guide to the Project Management Body of Knowledge (PMBOK Guide), 2009

[2] J. Robertson, Robertson, S., Full system analysis, WNT Warsaw, 2003

[3] Dennis A., Wixam B.H., System Analysis, Design, John Wiley & Sons, 2003

SECONDARY LITERATURE:

[1] The literature recommended by the teacher for specific project subjects.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Paweł Kaczmarek, pawel.kaczmarek@pwr.edu.pl

Zał. nr 5 do ZW 16/2020

FACULTY OF ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Zaawansowane zagadnienia robotyki**
Name of subject in English:	**Advanced Topisc in Robotics**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00201**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30			30	15
Number of hours of total student workload (CNPS)	60			90	60
Form of crediting	crediting with grade			crediting with grade	crediting with grade
For group of courses mark (X) final course	**X**				
Number of ECTS points	**7**				
including number of ECTS points for practical (P) classes				3	2
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1			2	1

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Knowledge of the subject Introduction to Robotics.
Knowledge of analytical geometry on the plane and in space.
Knowledge of fundamentals of matrix calculus.
Skills of working with Matlab environment.
Ability to model and to simulate dynamical systems.

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SUBJECT OBJECTIVES

C1. Enhancing knowledge on design of robotic systems.
C2. Enhancing knowledge on models of robotic systems.
C3. Attaining knowledge on robot motion planning and control.
C4. Attaining knowledge on robot applications.
C5. Developing skills of designing and programming of robotic systems.

C6. Developing skills of acquiring and critical analysis of information on modern robotic solutions.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 – Acquaintance with control architectures and methods of their implementation
PEU_W02 – Acquaintance with methods of modelling, motion planning and control for stationary and mobile robots
PEU_W03 – Acquaintance with applications of modern robots

relating to skills:
PEU_U01 – Ability to design and implement solutions for robot modelling, motion planning and control tasks
PEU_U02 – Ability to search, analyze and compare information on technnical solutions used in robotics

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Introduction to the course, terminology.	2
Lec 2	Robotic applications On-going research in social, medical and field robotics.	2
Lec 3	Designing a robotic system	2
Lec 4,5	Control architectures and their implementation. Software frameworks for architecture modeling.	4
Lec 6,7	The basics of force control and grasping	4
Lec 8,9	Grippers and non-serial kinematic structures	4
Lec 10-12	Robotic sensors	6
Lec 13	Visual servoing	4
Lec 14,15	Motion planning	2
	Total hours	**30**

Project		**Number of hours**
Pr 1	Introduction to the project. Presentation of topic and software tools.	4
Pr 2	Design and/or research experiments with selected robotic systems or system models	22
Pr 3	Presentation of project results.	4
	Total hours	**30**

Seminar		**Number of hours**
Sem 1	Introduction to topics undertaken during the course.	2
Sem 2	Presentations of selected topics on modern robotics.	11
Sem 3	Course summary.	2
	Total hours	**15**

TEACHING TOOLS USED
N1. Lecture N2. Project consulting N3. Seminar N4. Consultations N5. Independent work – self study and preparation for tests N6. Independent work – preparation of a project N7. Independent work – preparation of seminar presentations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcome code	Way of evaluating learning outcome achievement
F1	PEU_U01	Evaluation of project assignments
F2	PEU_U02	Presentation of selected topics, activity in discussions
F3	PEU_W01 - PEU_W03	Written test, essay on selected topics
C=F1+F2+F3 (in order to pass the course, all forming grades must be positive)		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Handbook of robotics. Springer, 2008. [2] P. Corke. Robotics, Vision and Control. Fundamental Algorithms in MATLAB, Springer, 2011. **SECONDARY LITERATURE:** [1] S.M. LaValle. Planning algorithms. http://planning.cs.uiuc.edu/ [2] L. Sciavicco, B. Siciliano. Modelling and Control of Robot Manipulator, Springer 2012 [3] S.Thrun i in. Probabilistic robotics. MIT Press, 2006. [4] The DARPA Urban Challenge. Springer, 2010.
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Janusz Jakubiak, Janusz.Jakubiak@pwr.wroc.pl

Zał. nr 5 do ZW 16/2020

FACULTY OF ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Elektroakustyka**
Name of subject in English:	**Electroacoustics**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00103**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	60		60		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course	**X**				
Number of ECTS points	**4**				
including number of ECTS points for practical (P) classes			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1		1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1 - The student would be introduce in the mechanical vibrations, acoustic and ultrasonic waves, quantities characterizing sound and ultrasound, physiology and psychology of hearing, speaking, properties of speech, transmission of audio signals as well as electro-acoustic and ultrasonic transducers, basic acoustical systems.

C2 - Ability for preparing and executing basic acoustic and ultrasonic measurements, speech signal characterization as well as analysis and interpretation of measurement results.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Student knows mechanical vibration of one- and multi degrees of freedom as well as continuous vibrating systems (string, membrane).

PEU_W02 Student knows propagation of acoustic and ultrasonic waves in gases and basic quantities characterizing an acoustic and ultrasonic wave.

PEU_W03 Student knows construction and functions of human hearing organ. Student knows subjective attributes of sound and their relationship with physical quantities.

PEU_W04 Student knows production process and properties of speech signal.

PEU_W05 Student knows quantities characterizing acoustic field in an open space.

PEU_W06 Student knows quantities characterizing acoustic field in rooms.

PEU_W07 Student knows basic acoustical systems. Student knows the electrical, mechanical and electrical analogies.

PEU_W08 Student knows elements of electroacoustic chain and distortion and artifacts of transmission of audio signals in this chain.

PEU_W09 Student knows principles of operation of electroacoustical transducers.

PEU_W10 Student knows principles of operation, basic parameters and characteristics of microphones and loudspeakers.

PEU_W11 Student knows principles of operation, basic parameters and characteristics of loudspeaker systems and earphones.

PEU_W12 Student knows principles of operation, basic parameters and characteristics of ultrasonic transducers.

relating to skills:

PEU_U01 Students knows principles of usage for electroacoustic equipment, how to prepare for the laboratory exercises and how to work up reports.

PEU_U02 Student is able to build a set-up for measurement and observation of vibrations in structures.

PEU_U03 Student is able to build a set-up for measurement and analysis of sound pressure levels. Student is able to perform measurements of parameters of microphones, sound level meters and filters.

PEU_U04 Student is able to perform basic pure tone air and bone conduction testing.

PEU_U05 Student is able to register and to measure parameters of speech signal.

PEU_U06 Student is able to perform measurements of frequency response and directional characteristics of loudspeakers and microphones.

PEU_U07 Student is able to measure parameters of ultrasonic transducers.

PEU_U08 Student knows basic concept and building the high-performance audio testing systems. Student is able to perform basic audio measurements using the high-performance audio testing systems.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Mechanical vibration of one- and multi degrees of freedom.	2
Lec 2	Propagation of acoustic and ultrasonic waves. Quantities characterizing sound and ultrasound.	3
Lec 3	Construction and functions of human hearing organ. Subjective attributes of sound and their relationship with physical quantities.	2
Lec 4	Production of speech signal. Properties of speech.	3

Lec 5	Quantities characterizing acoustic field in an open space. Properties of sound sources.	2
Lec 6	Quantities characterizing acoustic field in rooms.	2
Lec 7	Test no. 1.	2
Lec 8	Basic acoustical systems. Electrical, mechanical and electrical analogies.	2
Lec 9	Electro-acoustic chain and distortion and artifacts of transmission of audio signals in this chain.	2
Lec 10	Principles of operation of electro-acoustical transducers.	2
Lec 11	Microphones and loudspeakers.	2
Lec 12	Loudspeaker systems and earphones.	2
Lec 13	Ultrasonic transducers.	2
Lec 14	Test no. 2	2
	Total hours	**30**

Form of classes - laboratory		**Number of hours**
Lab 1	Introduction to laboratory. Overview of the Staff Regulations, principles of usage for equipment on laboratory stands, how to prepare for the laboratory exercises and how to work up reports.	2
Lab 2	Vibrations in structures.	4
Lab 3	Measurements and analysis of sound pressure levels.	4
Lab 4	Basic pure tone air and bone conduction threshold audiometry.	4
Lab 5	Acquisition and parameterization of speech signal.	4
Lab 6	Measurements of frequency response and directional characteristics of loudspeakers and microphones.	4
Lab 7	Measurement of ultrasonic transducers.	4
Lab 8	High-performance audio testing systems.	4
	Total hours	**30**

TEACHING TOOLS USED

N1. Lecture by means of the plate and slide.
N2. Consultation.
N3. Self-study and prepare for tests.
N4. Laboratory instructions on-line.
N5. Self-study and prepare for laboratory exercises and reports.

EVALUATION OF SUBJECT LERNING OUCTOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 - PEU_W06	Test in the first half of the semester
F2	PEU_W07 - PEU_W12	Test in the second half of the semester
F3	PEU_U01 - PEU_U08	Evaluation of theoretical knowledge

		about laboratory exercises
F4	PEU_U01 - PEU_U08	Evaluation of preparation of reports and correctness of analysis

P1: Successful completion of both tests. Mark on the basis of the sum of achieved scores.
P2: Positive scores from laboratory classes; P2 = (F3 + F4)/2
C = (P1+P2)/2; P1 and P2 must be positive.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Jens Blauertt, Ning Xiang: Acoustics for Engineers. Troy Lectures, Second Edition, Springer.
[2] F. Alton Everest, Mastr Handbook of Acoustics, Fourth EditionMc Graw-Hill.
[3] D. Ensminger, L. J. Bond, Ultrasonics. Fundamentals, Technologies and Applications, CRC Press, 2012.
[4] Blauert, Communication Acoustics, Springer Verlag 2005.
[5] Laboratory instruction on-line on the sites of Chair of Acoustics and Multimedia.
[6] Anders Brandt, Noise and Vibration Analysis. Wiley 2011.
[7] Stanley A.Gelfand, Essentials of Audiology, Thieme 2009.
[8] Bob Meltzer, Audio Measurement Handbook.

SECONDARY LITERATURE:

[1] Bruel&Kjaer Books

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

prof. dr hab. inż. Andrzej Dobrucki, andrzej.dobrucki@pwr.edu.pl

Zał. nr 5 do ZW 16/2020

FACULTY OF ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Elektroakustyka**
Name of subject in English:	**Electroacoustics**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00103**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	60		60		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course	**X**				
Number of ECTS points	**4**				
including number of ECTS points for practical (P) classes			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1		1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1 - The student would be introduce in the mechanical vibrations, acoustic and ultrasonic waves, quantities characterizing sound and ultrasound, physiology and psychology of hearing, speaking, properties of speech, transmission of audio signals as well as electro-acoustic and ultrasonic transducers, basic acoustical systems.

C2 - Ability for preparing and executing basic acoustic and ultrasonic measurements, speech signal characterization as well as analysis and interpretation of measurement results.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Student knows mechanical vibration of one- and multi degrees of freedom as well as continuous vibrating systems (string, membrane).

PEU_W02 Student knows propagation of acoustic and ultrasonic waves in gases and basic quantities characterizing an acoustic and ultrasonic wave.

PEU_W03 Student knows construction and functions of human hearing organ. Student knows subjective attributes of sound and their relationship with physical quantities.

PEU_W04 Student knows production process and properties of speech signal.

PEU_W05 Student knows quantities characterizing acoustic field in an open space.

PEU_W06 Student knows quantities characterizing acoustic field in rooms.

PEU_W07 Student knows basic acoustical systems. Student knows the electrical, mechanical and electrical analogies.

PEU_W08 Student knows elements of electroacoustic chain and distortion and artifacts of transmission of audio signals in this chain.

PEU_W09 Student knows principles of operation of electroacoustical transducers.

PEU_W10 Student knows principles of operation, basic parameters and characteristics of microphones and loudspeakers.

PEU_W11 Student knows principles of operation, basic parameters and characteristics of loudspeaker systems and earphones.

PEU_W12 Student knows principles of operation, basic parameters and characteristics of ultrasonic transducers.

relating to skills:

PEU_U01 Students knows principles of usage for electroacoustic equipment, how to prepare for the laboratory exercises and how to work up reports.

PEU_U02 Student is able to build a set-up for measurement and observation of vibrations in structures.

PEU_U03 Student is able to build a set-up for measurement and analysis of sound pressure levels. Student is able to perform measurements of parameters of microphones, sound level meters and filters.

PEU_U04 Student is able to perform basic pure tone air and bone conduction testing.

PEU_U05 Student is able to register and to measure parameters of speech signal.

PEU_U06 Student is able to perform measurements of frequency response and directional characteristics of loudspeakers and microphones.

PEU_U07 Student is able to measure parameters of ultrasonic transducers.

PEU_U08 Student knows basic concept and building the high-performance audio testing systems. Student is able to perform basic audio measurements using the high-performance audio testing systems.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Mechanical vibration of one- and multi degrees of freedom.	2
Lec 2	Propagation of acoustic and ultrasonic waves. Quantities characterizing sound and ultrasound.	3
Lec 3	Construction and functions of human hearing organ. Subjective attributes of sound and their relationship with physical quantities.	2
Lec 4	Production of speech signal. Properties of speech.	3

Lec 5	Quantities characterizing acoustic field in an open space. Properties of sound sources.	2
Lec 6	Quantities characterizing acoustic field in rooms.	2
Lec 7	Test no. 1.	2
Lec 8	Basic acoustical systems. Electrical, mechanical and electrical analogies.	2
Lec 9	Electro-acoustic chain and distortion and artifacts of transmission of audio signals in this chain.	2
Lec 10	Principles of operation of electro-acoustical transducers.	2
Lec 11	Microphones and loudspeakers.	2
Lec 12	Loudspeaker systems and earphones.	2
Lec 13	Ultrasonic transducers.	2
Lec 14	Test no. 2	2
	Total hours	**30**

Form of classes - laboratory		**Number of hours**
Lab 1	Introduction to laboratory. Overview of the Staff Regulations, principles of usage for equipment on laboratory stands, how to prepare for the laboratory exercises and how to work up reports.	2
Lab 2	Vibrations in structures.	4
Lab 3	Measurements and analysis of sound pressure levels.	4
Lab 4	Basic pure tone air and bone conduction threshold audiometry.	4
Lab 5	Acquisition and parameterization of speech signal.	4
Lab 6	Measurements of frequency response and directional characteristics of loudspeakers and microphones.	4
Lab 7	Measurement of ultrasonic transducers.	4
Lab 8	High-performance audio testing systems.	4
	Total hours	**30**

TEACHING TOOLS USED

N1. Lecture by means of the plate and slide.
N2. Consultation.
N3. Self-study and prepare for tests.
N4. Laboratory instructions on-line.
N5. Self-study and prepare for laboratory exercises and reports.

EVALUATION OF SUBJECT LERNING OUCTOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 - PEU_W06	Test in the first half of the semester
F2	PEU_W07 - PEU_W12	Test in the second half of the semester
F3	PEU_U01 - PEU_U08	Evaluation of theoretical knowledge

		about laboratory exercises
F4	PEU_U01 - PEU_U08	Evaluation of preparation of reports and correctness of analysis

P1: Successful completion of both tests. Mark on the basis of the sum of achieved scores.
P2: Positive scores from laboratory classes; P2 = (F3 + F4)/2
C = (P1+P2)/2; P1 and P2 must be positive.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Jens Blauertt, Ning Xiang: Acoustics for Engineers. Troy Lectures, Second Edition, Springer.
[2] F. Alton Everest, Mastr Handbook of Acoustics, Fourth EditionMc Graw-Hill.
[3] D. Ensminger, L. J. Bond, Ultrasonics. Fundamentals, Technologies and Applications, CRC Press, 2012.
[4] Blauert, Communication Acoustics, Springer Verlag 2005.
[5] Laboratory instruction on-line on the sites of Chair of Acoustics and Multimedia.
[6] Anders Brandt, Noise and Vibration Analysis. Wiley 2011.
[7] Stanley A.Gelfand, Essentials of Audiology, Thieme 2009.
[8] Bob Meltzer, Audio Measurement Handbook.

SECONDARY LITERATURE:

[1] Bruel&Kjaer Books

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

prof. dr hab. inż. Andrzej Dobrucki, andrzej.dobrucki@pwr.edu.pl

Zał. nr 5 do ZW 16/2020

Faculty of Electronics (W4) / Department of Cybernetics and Robotics (K29W04D02)

SUBJECT CARD

Name of subject in Polish: **Sztuczna inteligencja i widzenie maszynowe**
Name of subject in English: **Artificial Intelligence and Computer Vision**
Main field of study (if applicable): **Electronic and Computer Engineering (ECE)**
Profile: **academic**
Level and form of studies: **1st level, full-time**
Kind of subject: **facultative**
Subject code: **ECEA00203**
Group of courses: **Yes**

	Lecture	Exercise	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30	15	
Number of hours of total student workload (CNPS)	60		90	60	
Form of crediting	Examination		Crediting with grade	Crediting with grade	
For group of courses mark (X) the final course	X				
Number of ECTS points	7.0				
including number of ECTS points for practical (P) classes			3.0	2.0	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.0		2.0	1.5	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic programming skills.

SUBJECT OBJECTIVES

C1. Getting knowledge about knowledge representation, inferencing, searching, logic and probability in artificial intelligence scope.

C2. Getting knowledge about image aquisition and filtering, edge detection and recognition of shapes and objects on image.

C3. Getting knowledge about development of artificial intelligence methods and algorithms applications for solving given problems.

C4. Getting knowledge about development of image processing and computer vision applications.

SUBJECT LEARNING OUTCOMES
Relating to knowledge: PEU_W01 - Knows basic methods and algorithms of artificial intelligence. PEU_W02 - Knows basic methods and algorithms of computer vision. Relating to skills: PEU_U01 - Is able to solve basic problems using an artificial intelligence methods and algorithms. PEU_U02 - Is able to solve basic problems using an computer vision methods and algorithms.

PROGRAM CONTENT		
Lecture		**Number of hours**
Lec1	Introduction to artificial intelligence and computer vision.	2
Lec2	Basic aspects of image acquisition and computer vision.	2
Lec3	Image transformations and tools for image analysis.	4
Lec4	Noises and frequency aspects in computer vision.	2
Lec5	Fourier Transform, Discrete Fourier Transform and Filtering.	3
Lec6	Artificial intelligence tasks, uninformed and informed searching.	3
Lec7	Probability in artificial intelligence, Bayesian networks	2
Lec8	Markov chains, Dicrete Markov Chains.	2
Lec9	Optimization in artificial intelligence.	2
Lec10	Machine Learning.	2
Lec11	Neural Networks.	2
Lec12	Object detection algorithms.	4
	Total hours:	30

Laboratory		**Number of hours**
Lab1	Environment configuration and first steps in OpenCV.	4
Lab2	Camera calibration and image processing basics.	4
Lab3	Interpolation, sampling and quantization.	2
Lab4	Usage of histograms, DFT.	4
Lab5	Filtering and edge detection.	4
Lab6	Uninformed and informed searching. AN* algorithm.	4
Lab7	Bayesian networks, hidden Markov models.	4
Lab8	Neural Networks.	4
	Total hours:	30

Project		**Number of hours**
Pr1	Artificial intelligence project.	7
Pr2	Computer vision project.	8
	Total hours:	15

TEACHING TOOLS USED
N1. Traditional and/or online lecture using a multimedia tools.
N2. Laboratory, solving engineering problems using a computer.
N3. Project classes.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation: F — forming (during semester), C — concluding (at semester end)	Learning outcome code	Way of evaluating learning outcome achievement
F1	PEU_W01, PEU_W02	The final examination
F2	PEU_U01	Evaluation of lthe laboratory assignments
F3	PEU_U02	Evaluation of the project assignments
P = 0.4*F1 + 0.3*F2 + 0.3*F3 (in order to pass the course, all F1, F2 and F3 must be positive)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Russell, Norvig, Artificial Intelligence A Modern Approach, Third Edition, Prentice-Hall, 2010

[2] Forsyth, Ponce, Computer Vision A Modern Approach, Second Edition, Prentice-Hall, 2011

[3] Andreas C. Müller, Sarah Guido, Introduction to Machine Learning with Python: A Guide for Data Scientists, O'Reilly Media, 2016

SECONDARY LITERATURE:

[1] Szeliski, Computer Vision: Algorithms and Applications, Springer, 2011

[2] Zasoby https://opencv.org

[3] Joseph Howse, Joe Minichino, Learning OpenCV 4 Computer Vision with Python 3: Get to grips with tools, techniques, and algorithms for computer vision and machine learning, Packt 2020

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Mateusz Cholewiński, mateusz.cholewinski@pwr.edu.pl

FACULTY OF ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Systemy bezprzewodowe**
Name of subject in English:	**Wireless Systems**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00205**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	45		30		
Number of hours of total student workload (CNPS)	120		90		
Form of crediting	Examination		crediting with grade		
For group of courses mark (X) final course	X				
Number of ECTS points	**7**				
including number of ECTS points for practical (P) classes			4		
including number of ECTS points corresponding to classes that require direct participation of lecturers andother academics (BU)	2,5		1,5		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

C1. Gaining basic knowledge in the field of the wireless systems, including the basic notions and definitions as well as information related to their purposes, applications scope and used frequencies.

C2. Gaining the knowledge of the radio wave propagation (types of EM waves, propagation phenomena, models, media), physical phenomena occurring in the radio channel as well as techniques used to reduce adverse effects of these phenomena on the transmission performance and quality

C3. Gaining basic knowledge on calculating the radio link budget and determining coverage of wireless systems in various propagation environments

C4. Gaining knowledge on various types of wireless networks and systems enabling to distinguish their characteristics and application areas, architectures, techniques used for

transmission, system procedures and communication protocols, utilized communication techniques, medium access protocols and channel organizations
C5. Gaining skills in configuring and testing wireless equipment and systems, using diagnostic tools as well as observations and analysis of various events.
C6. Gaining skills in calculation of the radio link budget and determining coverage of wireless systems in indoor and outdoor environments using dedicated software tools
C7. Developing and strengthen social skills including emotional intelligence, involving the ability to work in a group of students, targeted at effective problem solving. Responsibility, honesty and fairness in conduct; observance of customs in academia and society.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 - has knowledge of the types and applications of wireless systems as well frequency bands in use, network architectures and functions of each individual component, the radio interfaces, the channels structure and common transmission techniques, capacity and spectral efficiency of wireless systems

PEU_W02 - knows transmission techniques used in wireless systems, including multiple access methods, medium access control methods, duplex communications, as well as techniques enabling improvement in the quality of service wireless systems, radio coverage and in access to the radio link

PEU_W03 - knows basic parameters associated with the wireless systems radio link, i.e. the coverage area, transmission and interference ranges, noises and interferences at the receiver input; has a deep knowledge of the transmitter and receiver parameters that are important for the communication range and the radio transmission quality

PEU_W04 - has basic knowledge how to determine the a radio link budget as well as communication range and capacity in radio systems; knows the principles of cellular and wireless systems planning

PEU_W05 - knows techniques of data transmission in cellular systems

PEU_W06 - has knowledge of the current state of the art and development trends in the field of mobile and wireless communications systems

relating to skills:

PEU_U01 – is able to determine the radio link budget, communication and interference range for mobile networks as well as plan cellular and wireless systems

PEU_U02 – is able to use diagnostic tools dedicated for testing and analysis of mobile communications systems

PEU_U03 – is able to use the spectrum analyzer, communication tester and measurement tools used to test the performance of mobile communication and wireless systems

PEU_U04 – is able to find and identify sources of the radio transmission using modern measuring devices

PEU_U05– is able to test operation, features, performance and functionality of mobile communications and wireless systems.

PEU_U06 – is able to configure selected devices of mobile and wireless networks

relating to social competences:

PEU_K01 - searching for information and its critical analysis, independent and creative thinking

PEU_K02 - an objective evaluation of arguments to justify the rational explanation and validation of her/his own point of view, using knowledge of wireless networks and

systems nature PEU_K03 - comply with the customs and rules of the academia society

PROGRAMME CONTENT		
Lecture		**Number of hours**
Lec 1	Introduction, wireless and radio systems overview, classification, applications, frequency bands, the basic concepts and definitions. Basic definitions: communication and interference ranges, coverage area compatible coexistence of radio systems, noises and interferences, transmitter and receiver parameters	3
Lec 2-3	Radio wave propagation phenomena and models	6
Lec 4	Antennas: classifications and parameters	3
Lec 5	Aspects of wireless system planning (the link budget, the communication range and coverage calculation)	3
Lec 6	Transmission techniques used in wireless systems enabling communications (multiplexing methods, medium access control methods and duplex communications methods) and improving the throughput and data transmission quality (i.e.: intelligent antenna arrays, diversity methods, MIMO, beamforming, tilting of antenna or antenna pattern, power control, adaptive coding and modulation techniques, ARQ)	3
Lec 7-9	Short Range Systems (Bluetooth, WLANs, ZigBee, UWB), fundamentals of Wireless Sensor Networks	9
Lec 10-11	PMR and PAMR networks (MPT1317, P25, DMR, TETRA, GoTa)	6
Lec 12	Introduction to cellular networks: system and networks architectures as well as procedures used in cellular systems to service mobile terminals	3
Lec 13-14	Mobile & cellular systems: 2G-5G	6
Lec 15	Review	3
	Total hours	**45**

Laboratory		**Number of hours**
Lab 1	Introductory classes: presentation of laboratory setups, terms of use and operation of the measuring equipment	2
Lab 2	The wireless system planning using software tools	4
Lab 3	Operating and programming of PMR and PAMR devices	4
Lab 4	Analysis and measurement methods of signals spectrum, generated by the radio communications systems. Testing mobile terminals using the communication tester	4
Lab 5	Network Monitor in mobile terminal	4
Lab 6	Configuration and testing EEE 802.11b/g/n devices	4
Lab 7	Configuration and testing of Bluetooth devices	4
Lab 8	Configuration and testing of ZigBee devices (setting up a simple mesh Wireless Sensor Network)	4
	Total hours	**30**

TEACHING TOOLS USED
N1. Lectures with the use of slides and simulation tools N2. Lecture materials for the subject (https://kursy. pwr.edu.pl/) N3. Analysis and discussion of obtained calculation results N4. Consultation N5. The student's independent work - preparation for exam N6. The student's independent work - individual preparation for practical classes/laboratory N7. Preparation of the report N8. Laboratory setups in the Laboratory N9. Simulation software for radio systems designing N10. Manuals and supplementary materials for laboratory exercise (https://kursy.pwr.edu.pl/)

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcome code	Way of evaluating learning outcome achievement
F1	PEU_W01 - PEU_W06 PEU_K01 - PEU_K03	Written and/or oral exam
F2	PEU_U01 - PEU_U06 PEU_K01 – PEU_K03	partial tests, discussions, written reports
P=F1*0,7+F2*0,3		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Ke-Lin Du and M.N.S. Swamy, "Wireless communication systems: from RF subsystems to 4G enabling technologies ", Cambridge University Press 2010, ISBN 978-0-521-11403-5, Electronic ISBN 978-0-511-71689-8 (available as e-book)

[2] Curt A. Levis, Joel T. Johnson, Fernando L. Teixeira., "Radiowave propagation : physics and applications " John Wiley & Sons Inc., Publication, 2010, ISBN 978-0-470-54295-8

[3] Kwang-Cheng Chen, Ramjee Prasad, "Cognitive radio networks" Wiley, 2009., ISBN 978-0-470-69689-7 (available as e-book)

[4] David Tse and Pramod Viswanath, "Fundamentals of wireless communication", Cambridge University Press, 2005, ISBN 0-521-84527-0

[5] Peter Stavroulakis,"TErrestrial Trunked RAdio - TETRA: A Global Security Tool", Springer 2007/

SECONDARY LITERATURE:

[1] www.etsi.org

[2] www.dmr.org

[3] www.3gpp.org

[4] www.itu.org

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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Zał. nr 5 do ZW 16/2020

FACULTY OF ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Optoelektronika**
Name of subject in English:	**Optoelectronics**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00204**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30			30	15
Number of hours of total student workload (CNPS)	90			90	30
Form of crediting	Crediting with grade			Crediting with grade	Crediting with grade
For group of courses mark (X) final course	X				
Number of ECTS points	**7**				
including number of ECTS points for practical (P) classes	–			3	1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1			2,5	0,5

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

C1: Gain an understanding of the fundamental laws of optoelectronics, properties of optoelectronic materials, and rules for the use of light to carry information.
C2: Gain an experience of the operation of a wide range of optoelectronic devices used in communications, sensing, and information technology basing on project-based learning.
C3: Achieve the ability to search for information about the selected scientific and technical challenges and present the information of a scientific content.

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:

PEU_W01: Explains the nature of light and some optical phenomena accompanying the propagation of light.
PEU_W02: Explains the physical aspects of light generation and properties of basic light sources & displays.
PEU_W03: Explains the physical aspects of light detection and properties of basic light detectors & image sensors.
PEU_W04: Explains the rules for encoding and transmission of information with the use of light.
PEU_W05: Explains the principles of three-dimensional (3D) vision.

Relating to skills:

PEU_U01: Interprets project-based instructions in the framework of application-centered problem.
PEU_U02: Analyses datasheet parameters of several optoelectronic components, chooses the appropriate working conditions, and uses them in an example application.
PEU_U03: Retrieves the information of a scientific content and make its critical analysis to draw conclusions.
PEU_U04: Presents to the audience data and information of a scientific nature as well as to formulate/justify opinions in a public discussion.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	World of optoelectronics – its applications and development trends.	1
Lec 1,2	The nature of light.	2
Lec 2	Fundamentals of semiconductor physics.	1
Lec 3	Thermal light sources: black body radiation, incandescent lamps.	2
Lec 4	Gas-discharge light sources: electrical discharges in gases, neon lamps, fluorescent tube.	2
Lec 5	Light-emitting diodes (LEDs): radiative recombination, single-color LEDs, white LEDs.	2
Lec 6	Introduction to laser physics.	2
Lec 7	Gas and solid-state lasers. He-Ne and laser diode power supplies.	2
Lec 8	Thermal detectors of optical radiation: thermoelectric effect, pyroelectricity, thermocouple, bolometer, pyrometer.	2
Lec 9	Photonic detectors of optical radiation: photoelectric emission, photoconductivity, photovoltaic effect, light-dependent resistor, photodiode, photovoltaic cell.	2
Lec 10	Image sensor technology.	2
Lec 11	Display devices: physical properties of liquid crystals, passive and active liquid-crystal displays (LCDs).	2
Lec 12	Display devices: organic LED (OLED) display, Digital Light Processing (DLP) technology.	2
Lec 13	Optical fibers: why use fiber optics? Application of optical fibers, principles of operation, single-mode and multi-mode fibers, introduction to fiber-optic communication: fibre-optic data link, fiber optic link power budget, fiber bandwidth.	2
Lec 14	3D vision: depth perception, stereoscopy and holography.	2

Lec 15	Stereoscopic techniques for 3D vision.	2
	Total hours	**30**

Project		**Number of hours**
Proj 1	Organizational issues. Introduction to an engineering workflow.	2
Proj 2–4	Design concepts and assumptions: i) analysing problem to be resolved, ii) formulation of functional requirements for the optoelectronic device to be designed iii) surveying information, iv) generating alternative solutions, v) division of work among the group, vi) description of operation based on the block diagram, vii) prior cost analysis, viii) safety issues.	6
Proj 5–8	Hardware design: i) formulation of a circuit diagram, ii) computer simulations of the device or its individual blocks, iii) discussion on practical aspects of the hardware implementation iv) providing a component list.	8
Proj 9–12	Software design: i) verbal (functional) and formal description of the software operation, ii) choice of language and programming tools.	8
Proj 13,14	Mechanical design: i) working on technical drawings of the parts used in the project, ii) printed circuit board design with the use of a specialized CAD software.	4
Proj 15	Project summary: i) the overall job description, ii) final cost analysis, iii) comparison with professional constructions, iv) presenting achievements and preparing for any relevant inquiry.	2
	Total hours	**30**

Seminar		**Number of hours**
Sem 1	Introduction. Choice of the content for individual seminar presentations.	2
Sem 2	Individual consultations. Choice of the information sources of a technical and scientific merit.	2
Sem 3, 4	Preliminary presentations. Focus discussion on future work.	4
Sem 5–8	Final presentations.	7
	Total hours	**15**

TEACHING TOOLS USED
N1. Traditional lecture using slides and movies. N2. Individual consultations. N3. Public presentation and discussion. N4. Individual work – search for scientific and technical information.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcome code	Way of evaluating learning outcome achievement
F1	PEU_W01 – PEU_W05	Written test.
F2	PEU_U01 – PEU_U02	Project documentation.

F3	PEU_U03 – PEU_U04	Seminar draft, multimedia presentation, participation in the general discussion.
C = (F1*3 + F2 + F3)/5 (positive grade under condition: F1>2 & F2>2 & F3>2)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] K. Booth, S. Hill "The essence of optoelectronics." Prentice Hall 1998.
[2] B. Saleh, M.C. Teich "Fundamentals of photonics." Wiley 2007.
[3] J. Wilson, J.F.B. Hawkes "Optoelectronics, an introduction." Prentice-Hall 1983.
[4] J.C. Palais "Fiber optic communications." 5th ed., Pearson/Prentice Hall 2005.

SECONDARY LITERATURE:

[1] S.L. Chuang "Physics of Photonics Devices" Wiley 2009.
[2] F. Träger (Ed.) "Springer Handbook of Lasers and Optics" Springer-Verlag 2012.
[3] P. Pereyra "Fundamentals of Quantum Physics." Springer-Verlag 2012.
[4] J.D. Gibson "The Communications Handbook." 2nd ed., CRC Press 2002.
[5] R.P. Feynman, R.B. Leighton, M. Sands "The Feynman Lectures on Physics. Vol.3" Addison-Wesley (1965).
[6] E.B. Wilson Jr. "An Introduction to Scientific Research" Courier Dover Publications, 1990.
[7] M. Heller "Questions to the Universe - Ten Lectures on the Foundations of Physics and Cosmology." Pachart Publishing House 1986.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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Zał. nr 5 do ZW 16/2020

FACULTY OF ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Inżynieria systemów sterowania**
Name of subject in English:	**Control Systems Engineering**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**elective**
Subject code:	**ECEA00206**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		45		
Number of hours of total student workload (CNPS)	90		120		
Form of crediting	Crediting with grade		Crediting with grade		
For group of courses mark (X) final course	**X**				
Number of ECTS points	**7**				
including number of ECTS points for practical (P) classes			4		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,5		2,5		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Passing courses Introduction to Automation, Introduction to Robotics

SUBJECT OBJECTIVES

After taking this course, students should be able to:

C1. Describe the structure and equipment base of industrial networks in the automation systems.
C2. Use industrial networks during designing and operating of the automation systems.
C3. Match, configure, and operate selected Fieldbus serial communication networks and Ethernet based networks.
C4. Acquisition of knowledge in the field of energy management systems and provide comfort intelligent buildings.
C5. Gain knowledge about the structure and equipment base of DCS and PLC(PAC)-based distributed automation systems.
C6. Learn how to match, configure, and operate selected distributed automation system.

C7. Gain knowledge about redundancy in automation systems, safety automation systems, and industrial networks
C8. Gain skills to use redundancy to design automation systems that comply with safety requirements.
C9. Gain skills to cooperate with team while performing a complex engineering task holding the role allocated in a team
C10.Search and use of online company catalogues and technical documentations.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge, students can:

PEU_W01 – explain the general structure and role of industrial networks in a production company.
PEU_W02 – describe the structure and equipment base of selected industrial networks.
PEU_W03 – characterize data exchange protocols in selected Fieldbus serial communication networks.
PEU_W04 – characterize data exchange protocols in selected Ethernet based networks.
PEU_W05 – explain the architecture, functionality and intellectual structures of building automation systems
PEU_W06 – use the methods of integrating building automation systems and integrating systems in intelligent buildings (BMS, IBMS and others).
PEU_W07– describe the general structure and equipment base of DCS distributed automation systems and PLC(PAC)-based automation systems.
PEU_W08 – use of redundancy in automation systems .
PEU_W09 – characterize safety automation systems and industrial networks.

relating to skills, students can:

PEU_U01 – configure PLC (PAC) controller for use in an industrial network.
PEU_U02 – prepare and use PLC (PAC) controller for data exchange in selected networks.
PEU_U03 – build, properly configure, and operate selected Fieldbus serial communication networks and Ethernet based networks.
PEU_U04- design the structure of energy management systems, technology and comfort in intelligent buildings.
PEU_U05 – configure and run a selected distributed automation system.
PEU_U06 – configure and run a distributed automation system that complies with safety requirements.
PEU_U07 – employ redundancy in designing of automation systems.
PEU_U08 – use SCADA systems or HMI device for data exchange observation.
PEU_U09 – choose adequate industrial computer network for automation systems.
PEU_U10 – select an adequate distributed systems of control engineering for automation.

relating to social competences, students:

PEU_K01 – are aware of importance of data search and analysis skills.
PEU_K02 – understand the necessity of self-education and skills development for the use of gained knowledge and skills.

PROGRAMME CONTENT		
Lecture		**Number of hours**
Lec1	Introduction to the course. Terminology and overview.	2
Lec2 Lec3	Industrial networks and protocols	4
Lec4	Applications of industrial networks	2
Lec5 Lec6	Overview of the SCADA + HMI systems	4
Lec7 Lec8	Overview of the DCS	4
Lec9	Intelligent buildings (Home Automation)	2
Lec10	Building management systems (BMS)	2
Lec11	Production management systems	2
Lec12	Safety automation systems.	2
Lec13	Safety integrity level (SIL)	2
Lec14	High-availability, fault-tolerant and safety-related systems	2
Lec15	Summary of lectures and final test.	2
	Total hours	**30**

Laboratory		**Number of hours**
Lab1	Occupational safety and health training. Class introduction and orientation.	3
Lab2	Configuration, running, and organizing data exchange in the Profibus DP serial network	3
Lab3	Configuration, running, and organizing data exchange in the Ethernet-based network with chosen protocol and an operator panel.	3
Lab4	Configuration, running, and organizing data exchange between controllers in ControlNet serial network .	3
Lab5	Configuration, running, and organizing data exchange between controllers in the Ethernet-based network with operator panel and Ethernet/IP protocol .	3
Lab6	Configuration, running, and organizing data exchange between controllers in the Ethernet-based network with Profinet protocol and SCADA system.	3
Lab7	Configuration and running of a selected distributed automation system with the use of redundancy.	3
Lab8	Configuration and running of a selected industrial network used in distributed automation systems.	3
Lab9	Configuration and running of a redundant industrial network system.	3
Lab10	Configuration and running a distributed automation system that complies with safety requirements.	3
Lab11	Configuration and running an control engineering for automatic products identification.	3
Lab12	Configuration and running of a energy consumption acquisition system.	3
Lab13	Configuration and running of a HVAC system.	3

Lab14	Configuration and running of a web server service on a selected industrial system.	3
Lab15	Final assessments	3
	Total hours	**45**

TEACHING TOOLS USED
N1. Traditional lecture using video projector N2. Laboratory classes N3. Consultations. N4. Independent work – preparation for laboratory classes. N5. Independent work – designing. N6. Independent work – self study.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes codes	Way of evaluating learning outcome achievement
P1	PEU_W01 - PEU_W09	written test
P2	PEU_U01 - PEU_U10 PEU_K01 – PEU_K02	evaluation of laboratory reports
P = 0,5*P1 + 0,5*P2 (in order to pass the course, P1 and P2 must be positive)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Altman W.: *Process Control for Engineers and Technicians*, Elsevier 2005
[2] Barlet T.: *Idustrial Automated Systems*, Delmar Cengage Lerning 2011
[3] Mackay S., Wright E., Park J., Reynders D.: *Practical Industrial Data Networks*, Elsevier 2004
[4] Park J., Mackay S., Wright E.: *Practical Data Communications for Instrumentation and Control*, Elsevier 2003
[5] Pigan R., Metter M.*: Automating with Profinet*, Publicis Publishing, Erlangen, 2008
[6] Bolton W.: *Programmable Logic Controllers*, Elsevier 2003
[7] Fraden J.: *Handbook of Modern Sensors, Physics, Designs, and Applications,* AIP Press & Springer, New York 2003

SECONDARY LITERATURE:

[1] Lecture notes
[2] Industry automation newspapers
[3] Internet resources

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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Zał. nr 5 do ZW 16/2020

Faculty of Electronics (W4) / Department of Cybernetics and Robotics (K29W04D02)

SUBJECT CARD

Name of subject in Polish: **Systemy operacyjne czasu rzeczywistego**
Name of subject in English: **Real-time Operating Systems**
Main field of study (if applicable): **Electronic and Computer Engineering (ECE)**
Profile: **academic**
Level and form of studies: **1st level, full-time**
Kind of subject: **facultative**
Subject code: **ECEA00208**
Group of courses: **Yes**

	Lecture	Exercise	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30			45	
Number of hours of total student workload (CNPS)	90			180	
Form of crediting	Examination			Crediting with grade	
For group of courses mark (X) the final course	X				
Number of ECTS points	7.0				
including number of ECTS points for practical (P) classes				4.0	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.0			3.0	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Programming skills.
2. Operating systems basic knowledge.
3. Microcontrolers programming and usage basic knowledge.

SUBJECT OBJECTIVES

C1. Learn basic structure and functionalities of real-time operating systems.
C2. Getting the practical ability to use a real-time functionalities in RTOS.
C3. Getting the practical ability to program and deploy applications in selected RTOS.

SUBJECT LEARNING OUTCOMES
Relating to knowledge: PEU_W01 - Knows general design and functions of real-time operating systems. Relating to skills: PEU_U01 - Is able to create real time applications for given real time operating systems.

PROGRAM CONTENT		
Lecture		**Number of hours**
Lec1	Introduction to real-time operating systems.	2
Lec2	Basic aspects of operating systems, POSIX standard.	2
Lec3	PC architecture based (QNX, Xenomai) and microcontroler based systems overview.	2
Lec4	RTOS systems services: threads, processes. synchronization, timers.	4
Lec5	Scheduler, interrupt service routine.	2
Lec6	FreeRTOS: introduction and advanced functions.	4
Lec7	Xenomai: introduction and advanced functions.	4
Lec8	QNX: introduction.	2
Lec9	Real-time operating systems communication aspects.	4
Lec10	Example applications for RTOS systems.	2
Lec11	Summary of real-time operating systems material.	2
	Total hours:	30

Project		**Number of hours**
Pr1	Xenomai - threads creation, synchronization, ISR, memory security.	12
Pr2	FreeRTOS - threads creation, synchronization, ISR, memory security.	12
Pr3	Implementation of RTOS-based system using a requirements approved by a teacher.	21
	Total hours:	45

TEACHING TOOLS USED
N1. Traditional and/or online lecture using a multimedia tools. N2. Project classes. N3. Self work - self studying.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation: F — forming (during semester), C — concluding (at semester end)	Learning outcome code	Way of evaluating learning outcome achievement
F1	PEU_W01	Exam
F2	PEU_U01	Evaluation of project tasks
P = 0.4*F1 + 0.6*F2 (in order to pass the course, both F1 and F2 must be positive)		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE:
[1] B.P.Douglas: Real-Time Design Patterns: Robust Scalable Architecture for Real-Time Systems, Addison-Wesley, 2002
[2] J.Brown, B.Martin: How fast is fast enough? Choosing between Xenomai and Linux for real-time applications, Rep Invariant Systems, inc.
[3] Using the FreeRTOS Real Time Kernel - a Practical Guide - Standard Base Edition

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Zał. nr 5 do ZW 16/2020

FACULTY: ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Systemy wbudowane**
Name of subject in English:	**Embedded Systems**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**elective**
Subject code:	**ECEA00207**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30	15	
Number of hours of total student workload (CNPS)	90		60	60	
Form of crediting	Egzaminaton		Crediting with grade	Crediting with grade	
For group of courses mark (X) final course	x				
Number of ECTS points	**7**				
including number of ECTS points for practical (P) classes			2	2	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,5		1,5	1	

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. (Introduction to Microcontrollers).

SUBJECT OBJECTIVES

C1. Gaining knowledge of the design of programmable logic
C2. Gaining basic knowledge about the basic building blocks implemented in the structures of programmable devices
C3. Gaining basic knowledge of parallel processing
C4. Gaining ability to construct multi-processor systems
C5. Gaining knowledge of systems design modules for the Internet of Things (IoT)

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:

PEU_W01 - knows the basic principles of design of microprocessor systems

PEU_W02 - has the knowledge to microcontroller selection for the required output and peripheral circuits offered to a given application

PEU_W03 - knows the principles of designing and running the code performing specific tasks on the selected hardware platform

PEU_W04 - has knowledge of integrating a microcontroller with external systems, digital and analog

Relating to skills:

PEU_U01 - can use the information contained in the technical notes in the design process of embedded systems

PEU_U02 – is able to use the computer tools supporting the design and testing of software for the selected hardware platform

PEU_U03 - can create software in HDL languages

PEU_U04 - can use sub-blocks of FPGA

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec1	Introduction to the synthesis of digital electronics	2
Lec2 Lec3	The structures of programmable logic PLD, PLA, CPLD and FPGA	2
Lec4	HDL Hardware Description Languages: Verilog and VHDL. Components of the language. The structure of the code. Development Environments	4
Lec5	Implementation of the basic structures of logic: counters, encoders, decoders, multiplexers, etc.	2
Lec6	Core IP blocks. The design of HDL code using Core IP blocks.	2
Lec7	Methods of implementation of arithmetic operations in programmable logic. Algorithms multiplying and CORDIC	2
Lec8	Parallel processing. Implementation of blocks of soft-core and hard-core microprocessors.	2
Lec9	The test mid-semester	2
Lec10	Embedded systems. The components of embedded systems. Examples of applications.	2
Lec11 Lec12 Lec13 Lec14	The Internet of Things. Architecture modules used in the IoT. Transmission protocols - review, implementation. Basic principles of design of modules for IoT.	4
Lec15	Multicore processors and application processors. Scalar, superscalar and vector processors. The basic elements of multicore processors and their applications. Issues of ensuring data consistency. Usage in multimedia applications and security.	6
	Total hours	**30**

Form of classes – laboratory		Number of hours
La1	Introduction to the laboratory. Safety rules. Familiarization with the workplace. Introduction to the development environment.	3
La2	Simple logic operations. The simulator. Synthesis of circuits. Analysis of the resulting output file.	3
La3	Design, simulation, synthesis and verification of the operation of sequential logic circuits: counters, comparators, arithmetic-logic units, etc. Using Core IP blocks.	6
La4	Implementation of arithmetic operations.	6
La5	Communication interfaces. Ensuring communication between the modules and the PC.	6
La6	Application Processor software.	3
La7	Introduction to the laboratory. Safety rules. Familiarization with the workplace. Introduction to the development environment.	3
	Total hours	**30**

Form of classes - project		Number of hours
Pr1	Introduction to the course. Discussion of exemplary projects topics from Embedded Systems.	3
Pr2	Choice of projects themes.	2
Pr3	Problematic discussion	2
Pr4 Pr5	Presentation and discussion of proposed solutions.	4
Pr6	Problematic discussion	
Pr7 Pr8	Presentation of the implemented solutions.	4
	Total hours	**15**

TEACHING TOOLS USED
N1. Lectures using multimedia presentations and whiteboard. N2. Laboratory classes - discussions on solutions applied. N3. Class Project - problems discussion N4. Consultations N5. Self - preparation for laboratory classes N6. Self - preparing the project N7. Self -study and preparation for final test

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcome code	Way of evaluating learning outcome achievement
F1	PEU_W01 – PEU_W04	Final exam
F2	PEU_U03 – PEU_U04	Tests and report laboratory exercises
F3	PEU_U01 – PEU_U02	Presentations and implementation of the project
P = 0.5*F1+0.25*F2+0.25*F3, (positive grade under condition: F1>2 i F2>2 i F3>2)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Technical documentation of microcontrollers families Cortex-R and Cortex-A of vendors: Atmel, Cypress, Freescale, NXP (Philips Semiconductors), Silicon Labs, STMicroelectronics, Texas Instruments (available in the Internet).

[2] Lin, Ming-Bo, "Digital system designs and practices : using Verilog HDL and FPGAs", John Wiley & Sons (Asia), 2008

[3] Woods R., "FPGA - based implementation of signal processing systems", John Wiley and Sons, Ltd., 2008

SECONDARY LITERATURE:

[1] Frey B., "PowerPC Architecture Book, v. 2.02", http://www.ibm.com/developerworks/power/library/pa-archguidev2/

[2] Pong Chu, "FPGA Prototyping by VHDL Examples: Xilinx Spartan-3 Version", John Wiley and Sons, Ltd., 2008

[3] Kilts S., "Advanced FPGA Design", John Wiley and Sons, Ltd., 2007

[4] Webpages: www.xilinx.com, www.altera.com, www.atmel.com

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Grzegorz Budzyń, grzegorz.budzyn@pwr.edu.pl

Faculty of Electronics (W4) / Department of Field Theory, Electronic Circuits and Optoelectronics (K35W04D02)

SUBJECT CARD

Name of subject in Polish: **Lasery, światłowody i ich zastosowania.**
Name of subject in English: **Lasers, Fibers and Applications**
Main field of study (if applicable): **Electronic and Computer Engineering (ECE)**
Profile: **academic**
Level and form of studies: **1st level, full-time**
Kind of subject: **facultative**
Subject code: **ECEA00209**
Group of courses: **Yes**

	Lecture	Exercise	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		15
Number of hours of total student workload (CNPS)	90		90		30
Form of crediting	Crediting with grade		Crediting with grade		Crediting with grade
For group of courses mark (X) the final course	X				
Number of ECTS points	7.0				
including number of ECTS points for practical (P) classes			3.0		1.0
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.0		2.0		1.0

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES
C1. To make wider and deeper the knowledge of physics needed to understand physical phenomena in the field of electronics.
C2. Introduction into laser technique basics. Familiarization with the mostly used lasers types and their parameters.
C3. Understanding of basic knowledge of light propagation in fibers. Familiarization with optical fiber technology, basic types of fibers and their parameters.
C4. The acquisition of skills in experimental works in fiber optics domain (the start-up of fiber devices such as: fiber amplifier, fiber laser, modulation and detection in fiber systems in representative experiments).
C5. Acquiring the ability to obtain information from the scientific materials written in English.
C6. Acquiring the ability in preparation presentations in English.

SUBJECT LEARNING OUTCOMES
Relating to knowledge:
PEU_W01 - Student has wider and deeper knowledge into physics needed to understand physical phenomena in electronics.
PEU_W02 - Student understands quantum mechanics principles of laser operation. Knows the main types of lasers and their basic parameters. Has knowledge about typical applications of lasers.
PEU_W03 - Student knows principles of optical fiber operation. Knows optical fibers types, their parameters and applications.
Relating to skills:
PEU_U01 - Student can perform elementary experiments in the field of lasers and optical fiber techniques. He can work with such devices fiber amplifiers, fiber lasers, light modulation and detection. He can set-up a simple interferometer and use it to basic measurements. He can apply lasers and optical elements in basic experiments.
PEU_U02 - Student is able to find the necessary information from the conference materials written in English in optocommunications or optoelectronics.
PEU_U03 - Student is able to prepare and to present a talk on chosen subject in English.

PROGRAM CONTENT		
Lecture		**Number of hours**
Lec1	Principles of lasers, laser resonator, longitudinal and transverse modes of laser radiation.	2
Lec2	Laser operation types: CW wavelength selection and tuning, pulsed Q-switched, pulsed mode-locked.	2
Lec3	Gas lasers and solid state lasers.	2
Lec4	Semiconductor lasers and other types of lasers.	2
Lec5	Basics of laser interferometry, homodyne and heterodyne interferometers. Laser spectroscopy basics.	2
Lec6	Lasers in technology, laser machining and micromachining. Lasers in biomedical applications.	2
Lec7	Principles of optical fibers, light propagation in optical fibers.	2
Lec8	Optical fiber characteristics and typical parameters.	2
Lec9	Special optical fibers (polarization maintaining, Photonic Crystal Fiber, planar fibers).	2

Lec10	Fiber technology: fabrication, fiber cables and patchcords, fiber connectors and splices, parameters measurements - reflectometry.	2
Lec11	Passive fiber-optic components. Active fiber optic components: EDFA, fiber modulators.	2
Lec12	Modern fiber-optic communication systems based on Wavelenth Division Multiplexing technique (WDM, DWDM, CWDM, etc).	2
Lec13	High power optical fiber technology. Double clad fibers, large mode area fibers. Fiber lasers and MOPA systems, chirped pulse amplification technique.	2
Lec14	Examples of advanced laser and fiber technology. Nonlinear optical effects, sub-picosecond pulse generation, supercontinuum generation.	2
Lec15	Final test.	2
	Total hours:	30

Laboratory		**Number of hours**
Lab1	Introduction, safety issues in the laboratory, organizing matters.	2
Lab2	He-Ne lasers. Laser beam propagation, light diffraction, holograms.	2
Lab3	Semiconductor laser. Measurements of basic parameters and characteristics measurements and their temperature dependence.	2
Lab4	Michelson interferometer. Optical alignment of the set-up and basic measurements.	2
Lab5	Light modulation – acoustooptical Bragg modulator.	2
Lab6	Light modulation – electrooptical modulators.	2
Lab7	Solid state microchip laser with second harmonic generation.	2
Lab8	Basic parameters of optical fibers. Fiber pigtailing principles.	2
Lab9	Basic passive fiber components: couplers, circulators, fiber isolators, collimators.	2
Lab10	Optical fiber connectors, fiber splicing.	2
Lab11	CW double clad fiber laser.	2
Lab12	Erbium Doped Fiber Amplifier (EDFA) – parameters and characteristics.	2
Lab13	Q-switched pulsed fiber laser.	2
Lab14	Modern laser and fiber scientific laboratory – guided tour through: ultrafast lasers laboratory, micromachining laboratory, medium and high power optical amplifiers and lasers laboratory.	2
Lab15	Compensatory term.	2
	Total hours:	30

Seminar		**Number of hours**
Sem1	Introductory meeting. Description of subject and rules of seminar: distribution of seminar subjects.	2
Sem2	The seminar is based on presentation by each student individually twice through the semester about 20 minutes talk based on chosen scientific papers dealing with subjects: lasers technology, laser applications, optical fibers, fiber devices and amplifiers, waveguide and optoelectronic devices, nonlinear optics.	13
	Total hours:	15

TEACHING TOOLS USED
N1. Classroom (blackboard and chalk)
N2. Projector, computer with software (for example PowerPoint)
N3. Laboratory equipped into modern laser-fiber equipment
N4. Self-study of conference papers written in English
N5. Preparing and delivering a presentation in English
N6. Working alone (selfeducation)
N7. Consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation: F — forming (during semester), C — concluding (at semester end)	Learning outcome code	Way of evaluating learning outcome achievement
F1	PEK_W01-03	Final test.
F2	PEK_U02-03	Ratings for the preparation and presentation of tutorials.
F3	PEK_U01	Rating for the preparation for experiments and perform the experiment.
P = 0,4*F1 + 0,3*F2 + 0,3*F3 (in order to pass the course all, F1, F2 and F3 must be positive)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] J.T. Verdeyen, Laser Electronics, Prentice Hall, Englewood Cliffs, 1995

[2] O. Svelto, Principles of Lasers, Plenum Press, New York, 1998

[3] G.P. Agraval, Fiber-Optics Communication Systems, John Wiles&Sons, third edition, 2002

[4] E. Desurvire, Erbiu-Doped Fiber Amplifiers, Device and System Developments, Wiley-Interscience, 2002

[5] Edited by A. Dutta, N. Dutta, M. Fujiwara, WDM Technologies: Passive Optical Componenets, Academic Press, Elsevier Science, 2003

[6] C.M. DeCusatis, C.J. SherDeCusatis, Fiber Optic Essentials, Academic Press, Elsevier Science, 2006

SECONDARY LITERATURE:

[1] J.F Ready, Industrial Applications of Lasers 2nd ed., Academic Press, 1997

[2] Edited by I.P. Kaminow, T.LKoch, Optical Fiber Telecommunications III A&B, Academic Press, 1997

[3] F. Träger, Handbook of Lasers and Optics, Springer, 2007

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Paweł Kaczmarek, pawel.kaczmarek@pwr.edu.pl

FACULTY: Electronics

SUBJECT CARD

Name of subject in Polish:	**Elektronika medyczna**
Name of subject in English:	**Medical Electronics**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**optional**
Subject code:	**ECEA00212**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				15
Number of hours of total student workload (CNPS)	60				30
Form of crediting	Crediting with grade				Crediting with grade
For group of courses mark (X) final course	**X**				
Number of ECTS points	**3**				
including number of ECTS points for practical (P) classes					2
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1				0,5

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. ECEA015 Electronic Circuits
2. ECEA016 Introduction to Microcontrollers

SUBJECT OBJECTIVES

C1 – Acquiring knowledge about fundamentals of electromedical equipment construction
C2 – Acquiring knowledge in the field of basic electromedical techniques
C3 – Acquiring knowledge on the structure and operation of diagnostic devices
C4 – Acquiring knowledge on the structure and operation of supporting and therapeutic devices
C5 – Achieving ability to search and present information about selected topics of medical electronics

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 – describes the specificity of medical devices and basic medical techniques
PEU_W02 – explains the structure and operation of diagnostic devices
PEU_W03 – explains the structure and operation of supporting and therapeutic devices

relating to skills:
PEU_U01 – retrieves and interprets technical information about new solutions in medical electronics
PEU_U02 – prepares and presents information about medical electronics

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec1	Introduction to the lecture. Safety of electromedical devices (EMD).	2
Lec2	Specificity of EMD. Thermography. Ultrasounds techniques.	2
Lec3	Optical techniques. Radiography. Tomography.	2
Lec4	Neuromuscular system. Evoked potentials.	2
Lec5	Audiometry and eye diagnostics. EMG. Electromagnetic activity of the brain and heart. EEG, MEG.	2
Lec6	VCG, ECG, CTG, MCG.	2
Lec7	Circulatory system. Measurement of blood pressure and flow. Diagnostics of arterial walls.	2
Lec8	Circulatory system modelling. Pulse wave analysis. Phonocardiography. Gasometry. Respiratory system.	2
Lec9	Measurement of respiratory pressures and flows. Electrical equivalent models. Measurement of mechanical properties.	2
Lec10	Examinations of lung function. Measurement of gas concentrations. Analytical apparatus.	2
Lec11	Cardiostimulators, defibrillators. Circulatory system supporting.	2
Lec12	Artificial organs: senses, pancreas. Artificial heart and lung. Mechanical ventilators.	2
Lec13	Physiotherapy. Surgical devices.	2
Lec14	Telemedical systems and techniques of mobile medicine.	2
Lec15	Summing-up knowledge in the field of medical electronics	2
	Total hours	**30**

	Seminar	**Number of hours**
Sem1	Introduction. Choice of topics for seminar presentations.	1
Sem2	Individual consultations. Choice of information sources.	2
Sem3	Preliminary presentations. Discussions on future work.	4
Sem4	Final presentations.	8
	Total hours	**15**

TEACHING TOOLS USED
N1. Traditional lectures with the use of multimedia presentations N2. Consultations N3. Public presentation and discussion N4. Individual work

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01–PEU_W03	Final test
F2	PEU_U01, PEU_U02	Multimedia presentation, involvement in discussion
C = 2/3*F1 + 1/3*F2 (positive grade under condition: F1>2 & F2>2)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] J.D. Bronzino (ed.): The Biomedical Engineering Handbook (vol. 1 & 2). CRC Press, Boca Raton 2000.
[2] R. Perez: Design of Medical Electronic Devices. Academic Press, San Diego, CA 2002.
[3] C.R. Rao, S.K. Guha: Principles of Medical Electronics and Biomedical Instrumentation. Universities Press (India) Limited, Hyderabad 2001.
[4] J.G. Webster (ed.): Bioinstrumentation. John Wiley & Sons, Hoboken 2004.

SECONDARY LITERATURE:

[1] J.G. Webster (ed.): Medical Instrumentation: Application and Design. John Wiley & Sons, New York 1998.
[2] W. Torbicz, L. Filipczyński, R. Maniewski, M. Nałęcz, E. Stolarski (red.): Biopomiary. Akademicka Oficyna Wydawnicza EXIT, Warszawa 2001.
[3] M. Darowski, T. Orłowski, A. Weryński, J.M. Wójcicki (red.): Sztuczne narządy. Akademicka Oficyna Wydawnicza EXIT, Warszawa 2001.
[4] L. Chmielewski, J.L. Kulikowski, A. Nowakowski (red.): Obrazowanie biomedyczne. Akademicka Oficyna Wydawnicza EXIT, Warszawa 2003.
[5] G. Pawlicki, T. Pałko, N. Golnik, B. Gwiazdowska, L. Królicki (red.): Fizyka medyczna. Akademicka Oficyna Wydawnicza EXIT, Warszawa 2002.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Adam G. Polak, Ph.D., D.Sc., adam.polak@pwr.edu.pl

Zał. nr 5 do ZW 16/2020

FACULTY ELECTRONIC

SUBJECT CARD

Name of subject in Polish:	**Systemy i sieci telekomunikacyjne**
Name of subject in English:	**Communication Systems and Networks**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**optional**
Subject code:	**ECEA00210**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		15
Number of hours of total student workload (CNPS)	90		90		30
Form of crediting	crediting with grade		crediting with grade		crediting with grade
For group of courses mark (X) final course	**x**				
Number of ECTS points	**7**				
including number of ECTS points for practical (P) classes			3		1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,5		2		0,5

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. None.

SUBJECT OBJECTIVES

C1 - Obtaining general knowledge about architecture and operation of telecommunication systems and networks using different technologies and standards.
C2 – Obtaining the configuration skills of basic functions selected systems.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01: has general knowledge of telecommunication systems and networks functionality

relating to skills:
PEU_U01: is able to present an architecture of contemporary telecommunication networks and configure basic functionalities of selected systems

PROGRAMME CONTENT		
Lecture		**Number of hours**
Lec 1	Introduction. Characteristic of copper transmission media	2
Lec 2	Characteristic of optical transmission media	2
Lec 3-5	Access and core optical networks	6
Lec 6-7	Signalling in TDM networks	4
Lec 8	Signalling in H.323 and SIP-based networks	2
Lec 9	Introduction to traffic engineering	2
Lec 10	Methods of traffic load calculation	2
Lec 11-12	Loss systems and network dimensioning	4
Lec 13-14	Network management	4
Lec 15	Resume. Test.	2
	Total hours	**30**
Laboratory		**Number of hours**
Lab 1	Introduction. Health and safety training.	2
Lab 2-3	Characteristic of copper transmission media	4
Lab 4-6	Characteristic of optical transmission media	6
Lab 7-8	Testing of wired access networks - HDSL, ADSL, VDSL.	4
Lab 9	Testing of optical access networks FTTx	2
Lab 10	Configuration and analysis of H.323-based systems	2
Lab 11	Configuration and analysis of SIP-based systems	2
Lab 12-13	Communication interfaces and signalling on embedded systems	4
Lab 14-15	Communication applications on embedded systems	4
	Total hours	**30**
Seminar		**Number of hours**
Sem 1	Introduction	1
Sem 2	Traffic arrival processes, loss systems and queuing systems	2
Sem 3	Traffic load calculations	2
Sem 4	Traffic measurements	2
Sem 5	Telecommunication Management Network architecture	2
Sem 6	ISO/OSI Management	2
Sem 7	IT Service Management	2
Sem 8	Communication management platforms	2
	Total hours	**15**

TEACHING TOOLS USED
N1. Lecture (using blackboard, projector, slides) N2. Consultations

N3. Selfstudy – preparation for practical classes N4. Selfstudy – preparation for the test N5. Laboratory materials and instructions

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcome code	Way of evaluating learning outcome achievement
F1	PEU_W01	Written test
F2	PEU_U01	Reports, tests, presentations, discussions
P=0,5*F1+0,5*F2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Nader F. Mir, Computer and communication networks, Upper Saddle River : Prentice Hall, cop. 2007.
[2] Rajiv Ramaswami, Kumar N. Sivarajan, Galen H. Sasaki, Optical networks : a practical perspective, Elsevier : Morgan Kaufmann, cop. 2010.
[3] J.G. van Bosse, F.U. Devetak, „Signaling in telecommunication networks", Wiley 2007.
[4] Villy B. Iversen, „Teletraffic Engineering Handbook (and netw. planning", ITU.
[5] J. Richard Burke, Network management : concepts and practice, a hands-on approach, 2004.
[6] P. Golden, H.Dedieu, K. Jacobsen - "Fundamentals of DSL Technology", Auerbach Publications, 2006

SECONDARY LITERATURE:

[1] ITU-T Recommendations.
[2] ETSI Standards.
[3] G. Keiser - FTTX Concepts and Applications" John Wiley & Sons, Inc. 2006
[4] U. Black, Optical Networks Third Generation Transport Systems, Prentice Hall PTR, 2002

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Dr inż. Janusz Klink, janusz.klink@pwr.edu.pl

FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Elektronika**
Name of subject in English:	**Elektrotechnics**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**optional**
Subject code:	**ECEA00211**
Group of courses:	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		15		
Number of hours of total student workload (CNPS)	60		60		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course	**X**				
Number of ECTS points	**3**				
including number of ECTS points for practical (P) classes			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1		0,5`		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1. Knowing the rules for construction of low-voltage electrical installations.
C2. Getting to know the criteria of effectiveness of protection against installations with an operating voltage up to 1kV.
C3. Knowledge of the principles of the organization of safe operation of electrical equipment and first aid in cases of electric shock.
C4. Acquiring the ability to perform basic research of low-voltage electrical installations.
C5. Perform basic switching operations in power installations and control of operating voltages up to 1kV.

SUBJECT EDUCATIONAL EFFECTS

I. Relating to knowledge:

PEU_W01 - The student explains the construction of low-voltage electrical installations and knows the rules for the selection of its individual components.

PEU_W02 - The student has knowledge of systems and means of protection against used in low voltage installations.

PEU_W03 - The student knows the rules of the organization safe operation of electrical equipment and first aid in cases of electric shock.

II. Relating to skills:

PEU_U01 - A student performs basic measurements of electrical installations with rated voltages up to 1kV.

PEU_U02 - A student performs basic switching operations and elementary corrective actions in electrical systems up to 1kV.

III. Relating to social competences:

PEU_K01 - Students interact effectively in a team carrying out the measurements and connecting the electrical installation

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1, 2	General characteristics of regulations and standards relating to the construction equipment, installations and electrical networks	4
Lec 3, 4	Network systems and low-voltage installations. Types, principles of construction and design.	4
Lec 5, 6	Electrical machines and equipment. Types, principles of construction, types of protection from overload and short circuits.	4
Lec 7, 8	Protection class electrical appliances. International Protection Rating of enclosure electrical device.	4
Lec 9, 10	Basic security measures used in low voltage installations.	5
Lec 11,12	Fault protection measures used in low voltage installations.	5
Lec 13,14	The organization safe operation of electrical equipment.	3
Lec 15	Final test.	1
	Total hours	**30**

Laboratory		**Number of hours**
Lab 1	Admission: - Familiarize students with the principles of safety in the laboratory; - Familiarize students with support equipment	1
Lab 2	Performing measuring from the list in the Practical Electrotechnics Laboratory: Fault loop impedance measurements. Measurement of protective conductor continuity. Insulation resistance wires. Measurements RCDs. Earth resistance measurements.	7
Lab 3	Performing exercises switching from the list in the Practical Electrotechnics	7

	Laboratory: Combining basic circuit low voltage electrical installations (way switches, circuit breakers cross, bistable switches, stair machines, dusk sensors, PIR motion detectors).	
	Total hours	**15**

TEACHING TOOLS USED
N1. multimedia presentation N2. informative lecture N3. self study - preparation for laboratory class N4. self study - self studies and preparation for examination N5. tutorials

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 – PEU_W03	final test
F2	PEU_U01 – PEU_U02 PEU_K01	activity in the classroom
P = 0.51*F1+0.49F2; F1 i F2 >2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE

[1] The Electrical Engineering Handbook, *Wai-Kai Chen,* 2005 Elsevier Inc.
[2] IEC 60364 Electrical Installations for Buildings

SECONDARY LITERATURE

[1] Electrical installation guide, 2008 Schneider Electric

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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