Zał. Nr 1 do ZW 78/2023

PROGRAM OF STUDIES

FACULTY:	Information and Communication Technology
MAIN FIELD OF STUDY:	Computer Engineering
BRANCH OF SCIENCE:	Computer Science
DISCIPLINES:	D1 Computer Engineering and Telecommunications
EDUCATION LEVEL:	second-level studies
FORM OF STUDIES:	full-time studies
PROFILE:	general academic
LANGUAGE OF STUDY:	english

Content:

Resolution no. … of the Senate of Wroclaw University of Science and Technology

In effect since 2024/2025

Załącznik nr 3 do ZW 77/2023
Załącznik nr 1 do programu studiów

ASSUMED LEARNING OUTCOMES

FACULTY: **Faculty of Information and Communication Technology**
MAIN FIELD OF STUDY: **Computer Engineering**
EDUCATION LEVEL: **second-level studies**
PROFILE: **general academic**

Location of the main-field-of study:

Branch of science: **Engineering and technology**

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

Computer Engineering and Telecommunications

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

P7S – second degree characteristics corresponding to education at the second-level studies - 7 PRK level

W - category "knowledge"
U - category "skills"
K - category "social competences"

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"

… _INŻ – learning outcomes related to the engineer competences

Main field of study learning outcomes	**Description of learning outcomes for the main-field-of study** **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)				
K2ITE_W01	Has extended and in-depth knowledge of selected areas of mathematics and physics, necessary to understand issues in the field of the scientific discipline being studied.	P7U_W	P7S_WG	P7S_WG_INŻ
K2ITE_W02	He has knowledge in the field of creating and developing forms of individual entrepreneurship in the area appropriate for the studied field of study, has knowledge in the field of industrial property protection and copyright.	P7U_W	P7S_WK	P7S_WK_INŻ
K2ITE_W03	Has knowledge of development trends and new achievements in the field of IT.	P7U_W	P7S_WG P7S_WK	P7S_WG_INŻ P7S_WK_INŻ
K2ITE_W04	Knows the legal basis of information protection as well as the methods and IT tools used for information protection.	P7U_W	P7S_WG P7S_WK	P7S_WG_INŻ P7S_WK_INŻ
K2ITE_W05	Has knowledge of the use of information systems in various areas, knows the methods and algorithms supporting the design of such systems, current technologies and economic problems of IT investments.	P7U_W	P7S_WG	P7S_WG_INŻ
K2ITE_W06	Knows the methods and techniques of modeling, analysis and evaluation of information systems.	P7U_W	P7S_WG	P7S_WG_INŻ
K2ITE_W07	Has an ordered and theoretically founded knowledge of selected IT fields; knows and understands, in a greater extent, selected issues constituting advanced	P7U_W	P7S_WG	P7S_WG_INŻ

	detailed knowledge, appropriate for the education program within the selected specialization.			
K2ITE_W08	Has extended knowledge of machine learning and artificial intelligence methods.	P7U_W	P7S_WG	P7S_WG_INŻ
K2ITE_W09	Has extended and deepened knowledge of advanced programming techniques, including software design and development tools.	P7U_W	P7S_WG	P7S_WG_INŻ
SKILLS (U)				
K2ITE_ U01	Has knowledge, skills and competences in the field of a foreign language in accordance with the requirements specified for the additional level B2 + ESOKJ and higher in the field of scientific and technical language related to the studied discipline and related issues.	P7U_U	P7S_UK	
K2ITE_U02	Can think critically and argue his opinion.	P7U_U	P7S_UK	
K2ITE_U03	Is able to perform a design task for the needs of a problem-oriented IT system, integrating knowledge from various fields and using a system approach and existing or conceptually new IT approaches and tools.	P7U_U	P7S_UW P7S_UO	P7S_UW_INŻ
K2ITE_U04	He can use appropriate methods and programming tools for modeling, analysis and evaluation of information systems.	P7U_U	P7S_UW	P7S_UW_INŻ
K2ITE_U05	Can define the directions and methods of acquiring knowledge; gather information; make the right choice of sources and information derived from them; make a critical assessment and creative interpretation of the acquired knowledge; plan your own lifelong learning.	P7U_U	P7S_UU	P7S_UW_INŻ
K2ITE_U06	Is able to present topics, present individual phases of an implemented project (e.g. master thesis), justify conclusions; knows the rules of creative discussion.	P7U_U	P7S_UK	
K2ITE_U07	Is able to independently carry out a project (e.g. diploma thesis) containing research aspects, including: • can obtain information from literature, databases and other sources, integrate it, interpret and critically evaluate,	P7U_U	P7S_UW	P7S_UW_INŻ

	• can formulate and test hypotheses related to research problems, • can use analytical, simulation and experimental methods to solve problems, • can plan and carry out experiments, including computer simulations, • can integrate knowledge from various fields and disciplines and apply a systemic approach, also taking into account non-technical aspects, • is able to assess the usefulness and the possibility of using new achievements (techniques and technologies), • can propose modifications and improvements to existing technical solutions, • is able to interpret the obtained research results, draw appropriate conclusions and formulate recommendations, • can write a master's thesis in accordance with formal requirements.			
K2ITE_U08	Is able to use the acquired detailed knowledge appropriate for the education program within the selected specialization - to formulate and solve complex and unusual problems and perform tasks in an innovative way in unpredictable conditions.	P7U_U	P7S_UW P7S_UO	P7S_UW_INŻ
K2ITE_U09	Can design, implement and manage data storage and processing systems.	P7U_U	P7S_UW	P7S_UW_INŻ
K2ITE_U10	He has advanced programming skills, is able to use advanced tools for designing, testing and implementing the software.	P7U_U	P7S_UW	P7S_UW_INŻ
SOCIAL COMPETENCES (K)				
K2ITE_K01	Is aware of the social consequences of engineering activities and the related responsibility for the decisions made. Understands the need to provide the society with information and opinions on the achievements of technology and other aspects of the activities of a technical university graduate. Understands the role of the mass-media. Is ready to	P7U_K	P7S_KR P7S_KO	

	create models of proper conduct in the social and professional environment.			
K2ITE_K02	Can think and act in a critical, creative and entrepreneurial manner, and properly prioritize the implementation of a complex task.	P7U_K	P7S_KK P7S_KO	
K2ITE_K03	Is aware of the importance and understanding of social and non-technical aspects of computerization.	P7U_K	P7S_KK P7S_KO P7S_KR	
K2ITE_K04	Is able to cooperate with the team in the implementation of a complex engineering task; to fulfill the entrusted role in the team; to prioritize tasks.	P7U_K	P7S_KR	

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Attachment no. 2. to the Program of Studies

DESCRIPTION OF THE PROGRAM OF STUDIES

Main field of study Computer Engineering
Specializations: *Advanced Computer Science (ACS)*
Internet Engineering (INE)

Profile general academic

Level of studies second-level

Form of studies full-time

1. General description

1.1 Number of semesters: 3	*1.2 Total number of ECTS points necessary to complete studies at a given level:* 90
1.3 Total number of hours: 972	*1.4 Prerequisites (particularly for second-level studies):* Candidates for second-level studies in Computer Engineering may be recruited after obtaining at least an engineer's degree in the approved fields of study referred to in the document "Conditions and mode of recruitment for higher studies at Wrocław University of Science and Technology" for a given academic year.
1.5 Upon completion of studies graduate obtains professional degree of: MAGISTER INŻYNIER	*1.6 Graduate profile, employability:* The study program covers the issues of designing information systems for various applications in the economy and industry. Second level studies in English also develop towards research competences. Students acquire knowledge and skills necessary for the analysts and systems architects. Emphasis is placed on teaching the content which is current, modern and

	sought-after on the labor market. The study program gives a solid foundation for comprehensive competence development and the possibility of a wide choice of further education and career paths, including the research and development departments. The *Advanced Computer Science* studies' programme is focused on delivering multidisciplinary knowledge and developing theoretical and practical skills in modern areas of computer science (Machine Learning, Neural Networks, Optimisation, etc.), information technology and computer systems. We believe that students gain the most when they are involved in research (working on projects) individually and as a team while the lecturer is ready to advise and guide. Therefore, more than 65% of the course's programme is focused on active forms of learning like group projects, seminars, classes (tutorials) and laboratory training. The students will learn how to solve real-life IT and computer science problems, conduct research and gain information from the literature and other available sources. The graduates will be prepared for a role of a team leader and have extensive teamwork skills (critical thinking, collaboration, communication etc.). They will acquire the experience necessary for a professional career at research units, universities, colleges, and industry. The *Internet Engineering* programme covers the issues of creating websites and Internet applications. It includes knowledge of managing, reconfiguring and ensuring the security of Internet services, creating concurrent and

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[2]Traditional – enter T, remote – enter Z, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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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[7]KO – general education courses, PD – basic sciences courses, K – main field of study courses, S – specialization courses

	distributed applications. Provides UNIX / LINUX programming and administration skills, creating advanced embedded systems, designing and implementing Internet of Things solutions. Students are prepared to solve IT problems (including complexity, specification and implementation of solutions) and to manage an IT team. They have the ability to prepare, implement and verify projects, the ability to use IT tools in practice and programming skills and the knowledge to quickly adapt to the IT challenges. Students gain experience and skills in a project team working, as well as in managing, ensuring the availability and security of Internet services. Graduates can find employment in the creation and operation of software systems, Internet applications (e-business, e-commerce, e-banking), management systems in administration and military services. He or she works as a system administrator, team leader, designer or programmer of web, mobile and embedded applications, indicating threats resulting from cyber security and counteracting them both at the hardware and software level. Good theoretical preparation, experience, specific practical knowledge acquired thanks to access to modern computer and network equipment and design tools, good knowledge of foreign languages, allow graduates to easily adapt to the needs of the labour market and find interesting and well-paid jobs both in domestic companies, as well as and foreign, both in small and large research, design and implementation. Graduates have the experience necessary for a professional career and to undertake level III (Ph.D.) education.

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1.7 Possibility of continuing studies: eligibility to apply for admission to a doctoral school, non-degree postgraduate programs	*1.8 Indicate connection with University's mission and its development strategy:* The study program is consistent with the mission and strategy of the university, in particular with the priority research area: Information technologies, data science and artificial intelligence, specified in the Wrocław University of Science and Technology Strategy for 2023-30.

2. Detailed description

2.1 Total number of learning outcomes in the program of study: W (knowledge) = 9, U (skills) = 10, K (competences) = 4, W + U + K = 23

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

not applicable

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:

not applicable

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) 71

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) not applicable

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

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The expected learning outcomes are consistent with the needs of the labor market. This position is justified by the results of analyzes of labor market needs, among others in the following studies:

- Raport z II edycji badań Branża IT w dobie pandemii „Analiza sytuacji pracodawców, kluczowych trendów rozwojowych i zapotrzebowania na kompetencje", podsumowujący II edycję badań realizowanych w latach 2020-2021. https://www.parp.gov.pl/component/publications/publication/branzowy-bilans-kapitalu-ludzkiego-ii-sektor-it
- I edycja raportu „Potrzeby kompetencyjne w kontekście skutków pandemii koronawirusa „Raport zbiorczy z badania dotyczącego działań anty COVIDowych w sektorach: Informatyka oraz Telekomunikacja i Cyberbezpieczeństwo.", Warszawa 2021. Badanie przeprowadzone w ramach działania Sektorowej Rady ds. Kompetencji – Informatyka oraz Sektorowej Rady ds. Kompetencji Telekomunikacja i Cyberbezpieczeństwo. https://www.piit.org.pl/__data/assets/pdf_file/0023/19184/raport_zbiorczy.pdf
- Raport „Wrocławski sektor IT", 2019, https://www.wroclaw.pl/biznes/files/dokumenty/24951/Raport_ARAW_10-10-2019_Wroclawski_sektro_IT_web.pdf
- "Przygotuj się na rekrutację IT w 2022 roku - Rynek pracy IT w Polsce", https://nexttechnology.io/pl/raport-rynek-pracy-it-w-polsce/

The compliance of educational outcomes is in line with expectations both in the local labor market (graduates easily find employment in companies operating on the local market, such as VOLVO, NSN, Teta, InsERT, Sente, Techland) and in the national or even global market (many graduates find employment in international corporations abroad, such as Microsoft or IBM).

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 subjects / groups of classes marked with the BU[1] code) **46,9 (ACS), 46,26 (INE) ECTS**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
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[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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

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

Number of ECTS points for obligatory subjects	6
Number of ECTS points for optional subjects	0
Total number of ECTS points	6

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 subjects/group of classes denoted with code P)

Number of ECTS points for obligatory subjects	17
Number of ECTS points for optional subjects	42 (ACS), (INE)
Total number of ECTS points	59 (ACS), (INE)

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 subjects/group of classes denoted with code O)

9 ECTS points

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

55 ECTS points

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

Implementing the curriculum, students attend organized classes, according to the regulations of higher education at the Wrocław University of Science and Technology (available at the web page of the University). Classes are conducted in the forms specified in the study regulations, while both traditional methods and teaching tools as well as opportunities offered by the university e-learning platform are used. Besides the classes, the lecturers are available to students at the hours of consultation designated and announced on the website or teaching service system (USOS). An important element of learning is student's own work, consisting in preparing for classes (based on materials made available by the teachers and the recommended literature), studying literature, preparing reports, preparing for tests and exams.

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[2]Traditional – enter T, remote – enter Z, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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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For each PRK learning outcome, the codes of courses present in the study program are assigned. Completing these courses (this course) means getting the effect. The courses are passed on the basis of forms of control of the acquired knowledge, skills and social competences, defined in the course cards. The student's failure to achieve the learning outcomes attributed to the course results in the failure to complete the course and the need to repeat it.

Passing each semester of study is conditioned by obtaining a number of ECTS points given by a study program, which is synonymous with achieving the majority of learning outcomes provided for a given semester. Student is obligated to repeat all the not completed courses during the following semesters, thus achieving the remaining learning outcomes.

Positive completion of studies is possible after the student has achieved all the learning outcomes determined by the study program.

The quality of classes and learning outcomes are controlled by the Faculty Quality Assurance System, including, among others, the procedures for creating and modifying education programs, individualizing study programs, implementing the teaching process and diploma. Quality control of the educational process includes evaluation of learning outcomes achieved by students. Quality control of the conducted classes is supported by class inspections and surveys, carried out according to well-defined faculty procedures.

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
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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. 5 ECTS points):*

No.	Subject group of classes code	Name of Subjectgroup of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			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	W08W04-SM4002	Social Communication					1	K2ITE_U02K2ITE_K01	15	50	2		0,68	T/Z	Z	O		P(1)	KO
2	W08W04-SM4006	Entepreneurship (**GK**)	1				1	K2ITE_W02 K2ITE_K02	30	75	3		1,36	T/Z	Z (w)	O		P (1,5)	KO
		Total	1				2	-	45	125	5	0	1,8	-	-	-	-	P(2,5)	-

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					
1	**0**	**0**	**0**	**2**	**45**	**125**	**5**	**0**	**2,04**

4.1.2 List of basic sciences blocks

4.1.2.1 *Mathematics* block

No.	Subject		Weekly number of hours	Learning effect symbol	Number of hours	Number of ECTS points	Form[2] of Subjectgr	Way[3] of crediting	Subjectgroup of classes

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – in brackets enter the number of ECTS points assigned to practical courses
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	group of classesco de	Name of Subjectgroup of classes (denote group of courses with symbol **GK**)	lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes	oup of courses		University -wide[4]	Concerni ng scientific activities[5]	Practical[6]	Type[7]
1	W04ITE-SM4013	Discrete Mathematics (**GK**)	2			2		K2ITE_W01 K2ITE_U04	60	125	5		3,04	T/Z*	E (w)			P (2,5)	K
		Total	**2**	**0**	**0**	**2**	**0**	–	**60**	**125**	**5**	**0**	**2,48**	–	–	–	**-**	**P (2,5)**	–

4.1.2.2 *Physics* block

No.	Subject group of classes code	Name of Subjectgroup of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of Subjectgr oup of courses	Way[3] of crediting	Subjectgroup of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerni ng scientific activities[5]	Practical[6]	Type[7]
1	W11ITE-SM4001	Physics	1					K2ITE_W01	15	25	1		0,68	T/Z	Z	O			PD
		Total	**1**	**0**	**0**	**0**	**0**	–	**15**	**25**	**1**	**0**	**0,68**	–	–	–	**-**	**P (0)**	–

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]
lec	cl	lab	pr	sem					
3	**0**	**0**	**2**	**0**	**75**	**150**	**6**	**0**	**5,2**

[1]BU – number of ECTS points assigned to hours of classes requiring direct participation of academic teachers and other persons conducting classes
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[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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

4.1.3 List of the main field of study blocks

4.1.3.1 *Obligatory main field of study* blocks

No.	Subject group of classes code	Name of Subjectgroup of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			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	W04ITE-SM4010	Computer Project Management **(GK)**	2		1		1	K2ITE_W06 K2ITE_U03 K2ITE_K02 K2ITE_K03	60	125	5		2,88	T/Z*	E (w)			P(2,5)	K
2	W04ITE-SM4017G	Optimization Methods: Theory and Applications (GK)	2			2		K2ITE_W05 K2ITE_W07 K2ITE_U08	60	125	5	5	2,72	T/Z*	Z(w)			P(2,5)	K
3	W04ITE-SM4018G	IT Applications in Business and Commerce (**GK**)	2			2		K2ITE_W05 K2ITE_K03 K2ITE_U03	60	125	5	5	2,88	T/Z*	Z(w)		DN	P (2,5)	K
4	W04ITE-SM4019G	Information Systems Modeling **(GK)**	2		1			K2ITE_W06 K2ITE_U04	45	75	3	3	2,04	T/Z*	Z (w)		DN	P(1,5)	K
5	W04ITE-SM4020G	Research Skills and Methodologies (**GK**)	1				2	K2ITE_W03 K2ITE_K04	45	75	3	3	2,04	T/Z	Z		DN	P (2)	K
6	W04ITE-SM4021G	Secure systems and networks **(GK)**	2		1			K2ITE_W04 K2ITE_U04	45	75	3	3	2,04	T/Z*	Z (w)		DN	P(1)	K
		Total	**11**	**0**	**3**	**4**	**3**	**-**	**315**	**600**	**24**	**19**	**14,6**	**-**	**-**	**-**	**-**	**P(12)**	**-**

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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 (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					
11	**0**	**3**	**4**	**3**	**315**	**600**	**24**	**19**	**14,6**

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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 *Foreign languages* block *(min. 3 ECTS points):*

No.	Subject group of classes code	Name of Subjectgroup of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			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	SJO-SM0001	Foreing Language I		1				K2ITE_U01	15	30	1		0,63	T	Z	O		P (1)	KO
2	SJO-SM0002	Foreign Language II		3				K2ITE_U01	45	60	2		1,63	T	Z	O		P (2)	KO
		Total	**0**	**4**	**0**	**0**	**0**	**–**	**60**	**90**	**3**	**0**	**2,26**	**–**	**–**	**–**	**-**	**P (3)**	**–**

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					
0	**4**	**0**	**0**	**0**	**60**	**90**	**3**	**0**	**2,26**

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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 List of specialization blocks

4.2.4.1 *Specialization subjects (Advanced Computer Science - ACS)* blocks *(min. 41 ECTS points):*

No.	Subject group of classes code	Name of Subjectgroup 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 Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			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	W04ITE-SM4246P	Research Project				3		K2ITE_U08 K2ITE_K02	45	75	3	3	2,28	T	Z		DN	P (3)	S
2	W04ITE-SM4226	ACS Seminar 1					2	K2ITE_W07 K2ITE_U05	30	50	2	2	1,36	T/Z	Z		DN	P (2)	S
3	W04ITE-SM4247G	Modeling and Optimization of Computer Networks (**GK**)	1			2	1	K2ITE_W07 K2ITE_U08 K2ITE_U10 K2ITE_K04	60	150	6	6	3,04	T/Z*	E (w)		DN	P (4)	S
4	W04ITE-SM4248G	Information and Storage Management (**GK**)	1		1			K2ITE_W07 K2ITE_U09	30	50	2	2	1,36	T/Z*	Z (w)		DN	P (1)	S
5	W04ITE-SM4249G	Neural Networks (GK)	2			2		K2ITE_W07 K2ITE_W08 K2ITE_U08	60	150	6	6	2,88	T/Z*	Z (w)		DN	P (3)	S
6	W04ITE-SM4250G	Machine Learning (**GK)**	2		1	1		K2ITE_W08 K2ITE_U08 K2ITE_K01 K2ITE_K02	60	150	6	6	2,96	T/Z*	E (w)		DN	P (3)	S
7	W04ITE-SM4245	ACS Seminar 2					2	K2ITE_U06	30	75	3	3	1,36	T/Z	Z		DN	P (3)	S
8	W04ITE-SM4251G	Introduction to Computer Vision in Quality Control (**GK**)	2			2		K2ITE_W07 K2ITE_W09 K2ITE_U08	60	125	5	5	2,88	T/Z*	Z (w)		DN	P (2,5)	S
9	W04ITE-SM4252G	Natural Language Processing (GK)	1			2		K2ITE_W07 K2ITE_W08 K2ITE_U10	45	100	4	4	2,2	T/Z*	Z (w)		DN	P (2,5)	S
10	W04ITE-SM4253G	Research Project 2 (**GK**)				1	2	K2ITE_U08 K2ITE_K04 K2ITE_U05 K2ITE_K03	45	100	4	4	2,12	T/Z*	Z (p)		DN	P (4)	S
		Total	9	0	2	13	7		465	1025	41	41	22,44					P(28)	

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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 for specialization blocks - ACS:

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	**0**	**2**	**13**	**7**	**465**	**1025**	**41**	**41**	**22,44**

4.2.4.1 *Specialization subjects (Internet Engineering - INE)* blocks *(min. 41 ECTS points):*

No.	Subject group of classes code	Name of Subjectgroup 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 Subjectgroup of courses	Way[3] of crediting	Subjectgroup of classes			
			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	W04ITE-SM4116	Application Programming – Java and XML Technologies (**GK**)	2	1	1			K2ITE_W09 K2ITE_U10	60	125	5	5	2,72	T/Z*	Z (w)		DN	P (2,5)	S
2	W04ITE-SM4117	Information Systems Analysis (**GK**)	2		2			K2ITE_W07 K2ITE_U08	60	125	5	5	2,88	T/Z*	E (w)		DN	P (3)	S
3	W04ITE-SM4120G	Advanced Databases (**GK**)	2		2			K2ITE_W07 K2ITE_U09	60	125	5	5	2,72	T/Z*	Z(w)		DN	P (2,5)	S
4	W04ITE-SM4119	Softcomputing (**GK**)	2			2		K2ITE_W08 K2ITE_U08	60	125	5	5	2,88	T/Z*	Z (w)		DN	P (2)	S
5	W04ITE-SM4115	Multimedia and Computer Visualization (**GK**)	1			2		K2ITE_W07 K2ITE_U08	45	125	5	5	2,36	T/Z*	E (w)		DN	P (3)	S
6	W04-SM4114	Internet Engineering Seminar					2	K2ITE_U05 K2ITE_U06	30	75	3	3	1,36	T/Z	Z		DN	P (3)	S
7	W04ITE-SM4121G	Application Programming – Data Mining and Data Warehousing (**GK**)	2		2	1		K2ITE_W07 K2ITE_U09	75	150	6	6	3,48	T/Z*	Z (w)		DN	P (4)	S

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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	W04ITE-SM4122 G	Application Programming – Mobile Computing (**GK**)	2		2		1	K2ITE_W09 K2ITE_U10	75	175	7	7	3,4	T/Z*	Z (w)		DN	P (4)	S
		Total	13	1	9	5	3		465	1025	41	41	21,8					P(24)	

Altogether for specialization blocks - INE:

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	**1**	**9**	**5**	**3**	**465**	**1025**	**41**	**41**	**21,8**

4.3 Training block - concerning principles of training crediting

Not applicable

4.4 „Diploma dissertation" block

Type of diploma dissertation	magister inżynier	
Number of diploma dissertation semesters	**Number of ECTS points**	**Code**
1	11 P(11)	W04ITE-SM4218 (ACS) W04ITE-SM4113 (INE)
Character of diploma dissertation		
Scientific-research		
Number of BU[1] ECTS points	1,84	

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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

5. Ways of verifying assumed learning outcomes

Form of classes	Ways of verifying assumed learning outcomes
lecture	written or oral crediting, colloquium (test), written exam, colloquium, oral exam
class	control reports average grade, homework assignments average grade, classwork grades, final test
laboratory	monitoring the preparation for and realization of laboratory exercises, evaluation of laboratory tasks, presentation of results with conclusions and discussion, pretest, report from laboratory
project	realization analysis of project assignment, written project documentation, presentation of project assumptions and final solution, presentation of project results with conclusions and discussion, evaluation of report, evaluation of project realization, project defense, participation in problem discussions, evaluations of project elements and final project, evaluation of simulation software, oral answers, discussions, presentation of initial results for diploma dissertation.
seminar	topic presentation, participation in discussion, report on seminar realization, evaluation of technical aspects and merits of the presentation
diploma dissertation	prepared diploma dissertation

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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. Range of diploma examination

Specialization Advanced Computer Science (ACS)

1. The requirements and tasks of the main design patterns of each layer of the multilayer information systems.
2. Graphs: definition, classification, algorithms, applications.
3. Enterprise and corporate applications - characteristics and technical aspects.
4. Payment card transactions: types of transactions, technological solutions, security.
5. Investigations using computer simulation: rules of experiment design, simulation tools, analysis of results, examples.
6. Project management – main groups of the processes.
7. Requirements description methods – the most popular ones, their pros and cons.
8. Users authentication in computer systems – methods, advantages, drawbacks.
9. Optimization using nature inspired algorithms
10. Inductive learning task and problem of overfitting.
11. The idea of multilayer perceptron learning.
12. Algorithms of pattern recognition.
13. Convolutional neural network.
14. Methods of image processing.
15. Computer vision applications in quality monitoring.
16. Modeling and optimization of survivable computer networks.
17. Modeling of computer networks using multi-commodity flows.
18. Stages of natural language processing.
19. Planning and conducting of scientific research.
20. Storage technology solutions (e.g. DAS, NAS, SAN).
21. Replication methods in storage systems.

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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

Specialization Internet Engineering (INE)

1. The requirements and tasks of the main design patterns of each layer of the multilayer information systems.
2. Graphs: definition, classification, algorithms, applications.
3. Enterprise and corporate applications - characteristics and technical aspects.
4. Payment card transactions: types of transactions, technological solutions, security.
5. Investigations using computer simulation: rules of experiment design, simulation tools, analysis of results, examples.
6. Project management – main groups of the processes.
7. Requirements description methods – the most popular ones, their pros and cons.
8. Users authentication in computer systems – methods, advantages, drawbacks.
9. Optimization using nature inspired algorithms
10. XSLT concept, area of applications. Describe language directives.
11. XML documents processing in Java: describe and compare available techniques.
12. Information systems analysis using Petri nets.
13. Privacy, access control and security management in relational database management systems.
14. XML extensions to relational database management systems and non-relational databases.
15. Purpose and short characteristics of main methods of data mining.
16. Security problems related to network communication.
17. Artificial neural networks: learning algorithms
18. Describe the color model "luminancechrominance" and its application
19. Discuss the JPEG compression algorithm
20. Data warehouse – purpose, characteristics and architectures.
21. Characteristic limitations of mobile systems related to hardware, software, user interface and networking

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

No requirements

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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. Plan of studies (attachment no. 4)

Approved by faculty 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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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 78/2023
Attachment no. 3 to Program of Studies

PLAN OF STUDIES

FACULTY: Information and Communication Technology

MAIN FIELD OF STUDY: Computer Engineering

EDUCATION LEVEL: second-level studies

FORM OF STUDIES: full-time studies

PROFILE: general academic

SPECIALIZATION: Advanced Computer Science (ACS)

LANGUAGE OF STUDY: english

In effect since 2024/2025

Plan of studies structure (optionally)

1) in ECTS point layout

(space for scheme of plan)

2) in hourly layout

(space for scheme of plan)

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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 subjects and groups of classes in semestral arrangement

Semester 1

Obligatory subjects / groups of classes Number of ECTS points 29

No.	Subject / groups of classesco de	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerni ng scientific activities[5]	Practical[6]	Type[7]
1	W11ITE-SM4001	Physics	1					K2ITE_W01	15	25	1		0,68	T/Z	Z	O			PD
2	W08W04 -SM4002	Social Communication					1	K2ITE_U02 K2ITE_K01	15	50	2		0,68	T/Z	Z	O		P(1)	KO
3	W04ITE-SM4010	Computer Project Management **(GK)**	2		1		1	K2ITE_W06 K2ITE_U03 K2ITE_K02 K2ITE_K03	60	125	5		2,88	T/Z*	E (w)			P(2,5)	K
4	W04ITE-SM4017 G	Optimization Methods: Theory and Applications (GK)	2			2		K2ITE_W05 K2ITE_W07 K2ITE_U08	60	125	5	5	2,72	T/Z*	Z(w)			P(2,5)	K
5	W04ITE-SM4018 G	IT Applications in Business and Commerce (**GK**)	2			2		K2ITE_W05 K2ITE_K03 K2ITE_U03	60	125	5	5	2,88	T/Z*	Z(w)		DN	P (2,5)	K
6	W04ITE-SM4019 G	Information Systems Modeling **(GK)**	2		1			K2ITE_W06 K2ITE_U04	45	75	3	3	2,04	T/Z*	Z (w)		DN	P(1,5)	K
7	W04ITE-SM4013	Discrete Mathematics (**GK**)	2			2		K2ITE_W01 K2ITE_U04	60	125	5		3,04	T/Z*	E (w)			P (2,5)	K
8	W04ITE-SM4020 G	Research Skills and Methodologies (**GK**)	1				2	K2ITE_W03 K2ITE_K04	45	75	3	3	2,04	T/Z	Z		DN	P (2)	K
		Total	**12**	**0**	**2**	**6**	**4**	–	**360**	**725**	**29**	**16**	**16,96**	–	–	–	**-**	**P (14,5)**	–

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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 subjects (minimum 15 hours in semester, 1 ECTS points)

No.	Subject / groups of classesco de	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerni ng scientific activities[5]	Practical[6]	Type[7]
1	SJO-SM0001	Foreing Language I		1				K2ITE _U01	15	30	1		0,63	T	Z	O		P (1)	KO
		Total	**0**	**1**	**0**	**0**	**0**	–	**15**	**30**	**1**	**0**	**0,63**	–	–	–	**-**	**P (1)**	–

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	**1**	**2**	**6**	**4**	**375**	**755**	**30**	**16**	**17,59**

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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 2

Obligatory subjects / groups of classes Number of ECTS points 3

No.	Subject / groups of classes code	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			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	W04ITE-SM4021G	Secure systems and networks **(GK)**	2		1			K2ITE_W04 K2ITE_U04	45	75	3	3	2,04	T/Z*	Z (w)		DN	P(1)	K
		Total	**2**	**0**	**1**	**0**	**0**	–	**45**	**75**	**3**	**3**	**2,04**	–	–	–	-	**P (1)**	–

Optional subjects / groups of classes(minimum 45 hours in semester, 2 ECTS points)

No.	Subject / groups of classes code	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			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	SJO-SM0002	Foreign Language II		3				K2ITE_U01	45	60	2		1,63	T	Z	O		P (2)	KO
		Total	**0**	**3**	**0**	**0**	**0**	–	**45**	**60**	**2**	**0**	**1,63**	–	–	–	-	**P (2)**	–

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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 subjects / groups of classes - Advanced Computer Science (minimum 285 hours in semester, 25 ECTS points)

No.	Subject / groups of classes code	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			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	W04ITE-SM4246P	Research Project				3		K2ITE_U08 K2ITE_K02	45	75	3	3	2,28	T	Z		DN	P (3)	S
2	W04ITE-SM4226	ACS Seminar 1					2	K2ITE_W07 K2ITE_U05	30	50	2	2	1,36	T/Z	Z		DN	P (2)	S
3	W04ITE-SM4247G	Modeling and Optimization of Computer Networks (**GK**)	1			2	1	K2ITE_W07 K2ITE_U08 K2ITE_U10 K2ITE_K04	60	150	6	6	3,04	T/Z*	E (w)		DN	P (4)	S
4	W04ITE-SM4248G	Information and Storage Management (**GK**)	1		1			K2ITE_W07 K2ITE_U09	30	50	2	2	1,36	T/Z*	Z (w)		DN	P (1)	S
5	W04ITE-SM4249G	Neural Networks (GK)	2			2		K2ITE_W07 K2ITE_W08 K2ITE_U08	60	150	6	6	2,88	T/Z*	Z (w)		DN	P (3)	S
6	W04ITE-SM4250G	Machine Learning (**GK)**	2		1	1		K2ITE_W08 K2ITE_U08 K2ITE_K01 K2ITE_K02	60	150	6	6	2,96	T/Z*	E (w)		DN	P (3)	S
		Total	**6**	**0**	**2**	**8**	**3**	–	**285**	**625**	**25**	**25**	**13,88**	–	–	–	-	**P (16)**	–

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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					
8	**3**	**3**	**8**	**3**	**375**	**750**	**30**	**28**	**17,55**

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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 subjects / groups of classes Number of ECTS points 3

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			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	W08W04 -SM4006	Entepreneurship (**GK**)	1				1	K2ITE_W02 K2ITE_K02	30	75	3		1,36	T/Z	Z (w)	O		P (1,5)	KO
		Total	**1**	**0**	**0**	**0**	**1**	–	**30**	**75**	**3**	**0**	**1,36**	–	–	–	-	**P (1,5)**	–

Optional subjects / groups of classes - Advanced Computer Science (minimum 345 hours in semester, 27 ECTS points)

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			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	W04ITE-SM4245	ACS Seminar 2					2	K2ITE_U06	30	75	3	3	1,36	T/Z	Z		DN	P (3)	S
2	W04ITE-SM4218	Final Project						K2ITE_U07 K2ITE_K03 K2ITE_K02	12	275	11	11	1,84	T	Z		DN	P (11)	S
3	W04ITE-SM4251G	Introduction to Computer Vision in Quality Control (**GK**)	2			2		K2ITE_W07 K2ITE_W09 K2ITE_U08	60	125	5	5	2,88	T/Z*	Z (w)		DN	P (2,5)	S
4	W04ITE-SM4252G	Natural Language Processing (GK)	1			2		K2ITE_W07 K2ITE_W08 K2ITE_U10	45	100	4	4	2,2	T/Z*	Z (w)		DN	P (2,5)	S
5	W04ITE-SM4253G	Research Project 2 (**GK**)				1	2	K2ITE_U08 K2ITE_K04 K2ITE_U05 K2ITE_K03	45	100	4	4	2,12	T/Z*	Z (p)		DN	P (4)	S
		Total	**3**	**0**	**0**	**5**	**4**	–	**345**	**675**	**27**	**27**	**10,4**	–	–	–	-	**P (23)**	–

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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					
4	**0**	**0**	**5**	**5**	**375**	**750**	**30**	**27**	**11,76**

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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. Set of examinations in semestral arrangement

Subject / groups of classescode	Names of subjects / groups of classesending with examination	Semester
W04ITE-SM4010 W04ITE-SM4013	Computer Project Management Discrete mathematics	1
W04ITE-SM4247G W04ITE-SM4250G	Modeling and Optimization of Computer Networks Machine Learning	2

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

Semester	Allowable deficit of ECTS points after semester
1	8
2	8

The deficit after semester 2 applies ONLY to courses/groups of courses not passed in semester 1 (all courses/groups of courses from semester 2 must be passed).

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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 78/2023
Attachment no. 3 to Program of Studies

PLAN OF STUDIES

FACULTY: Information and Communication Technology

MAIN FIELD OF STUDY: Computer Engineering

EDUCATION LEVEL: second-level studies

FORM OF STUDIES: full-time studies

PROFILE: general academic

SPECIALIZATION: Internet Engineering (INE)

LANGUAGE OF STUDY: english

In effect since 2024/2025

Plan of studies structure (optionally)

1) in ECTS point layout

(space for scheme of plan)

2) in hourly layout

(space for scheme of plan)

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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 subjects and groups of classes in semestral arrangement

Semester 1

Obligatory subjects / groups of classes Number of ECTS points 29

No.	Subject / groups of classes code	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			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	W11ITE-SM4001	Physics	1					K2ITE_W01	15	25	1		0,68	T/Z	Z	O			PD
2	W08W04-SM4002	Social Communication					1	K2ITE_U02 K2ITE_K01	15	50	2		0,68	T/Z	Z	O		P(1)	KO
3	W04ITE-SM4010	Computer Project Management **(GK)**	2		1		1	K2ITE_W06 K2ITE_U03 K2ITE_K02 K2ITE_K03	60	125	5		2,88	T/Z*	E (w)			P(2,5)	K
4	W04ITE-SM4017G	Optimization Methods: Theory and Applications (GK)	2			2		K2ITE_W05 K2ITE_W07 K2ITE_U08	60	125	5	5	2,72	T/Z*	Z(w)			P(2,5)	K
5	W04ITE-SM4018G	IT Applications in Business and Commerce (**GK**)	2			2		K2ITE_W05 K2ITE_K03 K2ITE_U03	60	125	5	5	2,88	T/Z*	Z(w)		DN	P (2,5)	K
6	W04ITE-SM4019G	Information Systems Modeling **(GK)**	2		1			K2ITE_W06 K2ITE_U04	45	75	3	3	2,04	T/Z*	Z (w)		DN	P(1,5)	K
7	W04ITE-SM4013	Discrete Mathematics (**GK**)	2			2		K2ITE_W01 K2ITE_U04	60	125	5		3,04	T/Z*	E (w)			P (2,5)	K
8	W04ITE-SM4020G	Research Skills and Methodologies (**GK**)	1				2	K2ITE_W03 K2ITE_K04	45	75	3	3	2,04	T/Z	Z		DN	P (2)	K
		Total	**12**	**0**	**2**	**6**	**4**	–	**360**	**725**	**29**	**16**	**16,96**	–	–	–	**-**	**P (14,5)**	–

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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 subjects (minimum 15 hours in semester, 1 ECTS points)

No.	Subject / groups of classesco de	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			lec	cl	lab	pr	sem		ZZU	CNPS	Total	DN[5] classes	BU[1] classes			University -wide[4]	Concerni ng scientific activities[5]	Practical[6]	Type[7]
1	SJO-SM0001	Foreing Language I		1				K2ITE _U01	15	30	1		0,63	T	Z	O		P (1)	KO
		Total	**0**	**1**	**0**	**0**	**0**	–	**15**	**30**	**1**	**0**	**0,63**	–	–	–	**-**	**P (1)**	–

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	**1**	**2**	**6**	**4**	**375**	**755**	**30**	**16**	**17,59**

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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 2

Obligatory subjects / groups of classes Number of ECTS points 3

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			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	W04ITE-SM4021G	Secure systems and networks **(GK)**	2		1			K2ITE_W04 K2ITE_U04	45	75	3	3	2,04	T/Z*	Z (w)		DN	P(1)	K
		Total	**2**	**0**	**1**	**0**	**0**	–	**45**	**75**	**3**	**3**	**2,04**	–	–	–	-	**P (1)**	–

Optional subjects / groups of classes(minimum 45 hours in semester, 2 ECTS points)

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			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	SJO-SM0002	Foreign Language II		3				K2ITE_U01	45	60	2		1,63	T	Z	O		P (2)	KO
		Total	**0**	**3**	**0**	**0**	**0**	–	**45**	**60**	**2**	**0**	**1,63**	–	–	–	-	**P (2)**	–

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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 subjects / groups of classes - Internet Engineering (minimum 285 hours in semester, 25 ECTS points)

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			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	W04ITE-SM4116	Application Programming – Java and XML Technologies (**GK**)	2	1	1			K2ITE_W09 K2ITE_U10	60	125	5	5	2,72	T/Z*	Z (w)		DN	P (2,5)	S
2	W04ITE-SM4117	Information Systems Analysis (**GK**)	2		2			K2ITE_W07 K2ITE_U08	60	125	5	5	2,88	T/Z*	E (w)		DN	P (3)	S
3	W04ITE-SM4120G	Advanced Databases (**GK**)	2		2			K2ITE_W07 K2ITE_U09	60	125	5	5	2,72	T/Z*	Z(w)		DN	P (2,5)	S
4	W04ITE-SM4119	Softcomputing (**GK**)	2			2		K2ITE_W08 K2ITE_U08	60	125	5	5	2,88	T/Z*	Z (w)		DN	P (2)	S
5	W04ITE-SM4115	Multimedia and Computer Visualization (**GK**)	1			2		K2ITE_W07 K2ITE_U08	45	125	5	5	2,36	T/Z*	E (w)		DN	P (3)	S
		Total	**9**	**1**	**5**	**4**	**0**	–	**285**	**625**	**25**	**25**	**13,56**	–	–	–	-	**P (13)**	-

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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					
11	**4**	**6**	**4**	**0**	**375**	**760**	**30**	**28**	**17,23**

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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 subjects / groups of classes Number of ECTS points 3

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			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	W08W04 -SM4006	Entepreneurship (**GK**)	1				1	K2ITE_W02 K2ITE_K02	30	75	3		1,36	T/Z	Z (w)	O		P (1,5)	KO
		Total	**1**	**0**	**0**	**0**	**1**	–	**30**	**75**	**3**	**0**	**1,36**	–	–	–	-	**P (1,5)**	–

Optional subjects / groups of classes - Internet Engineering (minimum 345 hours in semester, 27 ECTS points)

No.	Subject / groups of classescode	Name of subject / groups of classes (denote group of courses with symbol **GK**)	Weekly number of hours					Learning effect symbol	Number of hours		Number of ECTS points			Form[2] of subject / groups of classes	Way[3] of crediting	Subject / groups of classes			
			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	W04ITE-SM4114	Internet Engineering Seminar					2	K2ITE_U05 K2ITE_U06	30	75	3	3	1,36	T/Z	Z		DN	P (3)	S
2	W04ITE-SM4113	Final Project						K2ITE_U06	165	275	11	11	1,84	T	Z		DN	P (12)	S
3	W04ITE-SM4121G	Application Programming – Data Mining and Data Warehousing (**GK**)	2		2	1		K2ITE_W07 K2ITE_U09	75	150	6	6	3,48	T/Z*	Z (w)		DN	P (4)	S
4	W04ITE-SM4122G	Application Programming – Mobile Computing (**GK**)	2		2		1	K2ITE_W09 K2ITE_U10	75	175	7	7	3,4	T/Z*	Z (w)		DN	P (4)	S
		Total	**4**	**0**	**4**	**1**	**3**	–	**345**	**675**	**27**	**27**	**10,08**	–	–	–	-	**P (23)**	–

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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					
5	**0**	**4**	**1**	**4**	**375**	**750**	**30**	**27**	**11,44**

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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. Set of examinations in semestral arrangement

Subject / groups of classescode	Names of subjects / groups of classesending with examination	Semester
W04ITE-SM4010	Computer Project Management	1
W04ITE-SM4013	Discrete Mathematics	1
W04ITE-SM4117	Information Systems Analysis	2
W04ITE-SM4115	Multimedia and Computer Visualization	2

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

Semester	Allowable deficit of ECTS points after semester
1	8
2	8

The deficit after semester 2 applies ONLY to courses/groups of courses not passed in semester 1 (all courses/groups of courses from semester 2 must be passed).

[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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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, remote for lecture and seminar – Z*
[3]Exam – enter E, crediting – enter Z. For the group of classes – after the letter E or Z - enter in brackets the final subject form (lec, cl, lab, pr, sem)
[4]University-wide subject /group of classes – 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 subject / group of classes – enter P. For the group of classes – 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

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Attachment no. 4. to the Program of Studies

FACULTY Information and Communication Technology

SUBJECT CARD

Name of subject in Polish	**Praca dyplomowa**
Name of subject in English	**Diploma thesis**
Main field of study:	**Computer Engineering**
Specialization:	**Advanced Computer Science**
Profile:	**academic**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	**W04ITE-SM4218**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)				12	
Number of hours of total student workload (CNPS)				275	
Form of crediting (Examination / crediting with grade)				crediting with grade	
For group of courses mark (X) final course				X	
Number of ECTS points				11	
including number of ECTS points for practical classes (P)				11	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				1,84	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1 Acquiring the ability to formulate a research task in the area of computer engineering and plan own research experiments

C2 Acquiring the ability to conduct research, analyze and develop the results and prepare a master's thesis

SUBJECT EDUCATIONAL EFFECTS

relating to skills:

PEU_U01 Is able to formulate a research task in the field of computer engineering and prepare scenarios of research experiments

PEU_U02 Is able to obtain information from literature, documentation, databases and other sources

PEU_U03 Is able to complete a diploma thesis in the form of research work in the field of computer engineering

relating to social competences:

PEU_K01 Is able to critically evaluate existing and own scientific and technical solutions

PROGRAMME CONTENT		
Project		**Number of hours**
Proj 1	Analysis of the state of knowledge and technology in the area of the diploma thesis, review of research works on similar topics.	2
Proj 2	Formulation of the research task, specification of requirements.	2
Proj 3	Design and implementation of a research environment	4
Proj 4	Implementation of experiments, analysis of research results Preparation of research results and conclusions	4
	Total hours	12

TEACHING TOOLS USED
N1. Consultations N2. Problem oriented discussion N3. 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_U01- PEU_U03, PEU_K01	Evaluation of prepared diploma thesis
P=F1		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE:
[1] Literature agreed with the diploma thesis supervisor
[2] Technical documentation of the tools and technologies used
SECONDARY LITERATURE:
[1] Thesis recommendations – available on faculty web page
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
prof. dr hab. inż. Michał Woźniak, Michal.Wozniak@pwr.edu.pl

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Attachment no. 4. to the Program of Studies

FACULTY OF Information and Communication Technology

SUBJECT CARD

Name of subject in Polish	**:**	Seminarium Zaawansowanych Systemów Informatycznych 1
Name of subject in English	**:**	ACS Seminar 1
Main field of study (if applicable)	**:**	Computer Engineering
Specialization (if applicable)	**:**	Advanced Computer Science
Profile	**:**	academic
Level and form of studies	**:**	2nd level, full-time
Kind of subject	**:**	optional
Subject code	**:**	W04ITE-SM4226
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)					50
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 classes (P)					2
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)					1,36

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

none

SUBJECT OBJECTIVES

C1 Learn how to search selective knowledge needed to create their own original solutions.

C2 Learn how to prepare a presentation for showing own original ideas, concepts and solutions in a comprehensible way.

C3 The acquisition of the skill of creative discussion allowing in a factual and substantive way justified and defended own opinions

C4 Learn how to prepare the presentation illustrating own achievements

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Acquisition of knowledge about the current state of development in the field of computer science, computer systems and control systems

relating to skills:

PEU_U01 Ability to critical evaluation of scientific and technological solutions proposed by others persons

PEU_U02 Ability to present and discuss objectively and justify own original ideas and solutions

PEU_U03 Ability to prepare a presentation that contains own research plan based on analysis of the related works in literature

Seminar		Number of hours
Sem 1	Discussion of the topic of the seminar and recommended literature positions	2
Sem 2	Individual presentations based on the current state of knowledge related to the specialization's area of interest, including analysis of methods and used tools and techniques - examination of the considered problems.	6
Sem 3	Presentation of selected aspects of research methodology based on the recommended literature positions, exchange of views in a tutor group.	6
Sem 4	Discussion in a tutor group on the state of art. Establishing the concept of the initially proposed individual solutions to the own research problems.	6
Sem 5	Presentations summarizing the status of implementation of selected topics and objectives of the diploma thesis outlining original approach. Discussion in a tutor group. Presentation of written version of the MSc proposals.	10
	Total hours	**30**

TEACHING TOOLS USED

N1. Multimedia presentation
N2. Discussion - talk problematic
N3. Literature studies
N4. Develop a written documents
N5. 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_U01, PEU_U02	Assessment of presentation, the activity in the discussion, keeping deadlines.
F2	PEU_W01, PEU_U03	Evaluation of the quality of the final presentation and written version of the MSC proposal.
P = 0.4*F1+0.6*F2		

PRIMARY AND SECONDARY LITERATURE
[1] D. Remenyi, A. Money, „Research Supervision for Supervisors and their Students", API, 2012 [2] J. Apanowicz, „Zarys metodologii prac dyplomowych…", 1997 /in Polish/ [3] M. Korzyński, „Metodyka eksperymentu", WNT, 2006 /in Polish/ [4] D.C. Montgomery, „Design and Analysis of Experiments", 2012 [5] R. Tadeusiewicz, „Drogi i bezdroża statystyki w badaniach naukowych", 2002 /in Polish/ [6] A. Dennis, B. H. Wixam , "System Analysis, Design, John Wiley & Sons", 2003 [7] G.J. Cobb, "Introduction to Design and Analysis of Experiments", 1998 [8] References recommended by the teacher - literature related to the problems of the chosen research area
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Dr inż. Wojciech Kmiecik, Wojciech.kmiecik@pwr.edu.pl

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Attachment no. 4. to the Program of Studies

FACULTY: OF INFORMATION AND COMMUNICATION TECHNOLOGY

SUBJECT CARD

Name of subject in Polish	**:**	Seminarium specjalnościowe 2
Name of subject in English	**:**	ACS Seminar 2
Main field of study (if applicable)	**:**	Computer Engineering
Specialization (if applicable)	**:**	Advanced Computer Science
Profile	**:**	academic
Level and form of studies	**:**	2nd level, full-time
Kind of subject	**:**	optional
Subject code	**:**	W04ITE-SM4245
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)					75
Form of crediting					crediting with grade
For group of courses mark (X) final course					
Number of ECTS points					**3**
including number of ECTS points for practical classes (P)					3
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)					1,36

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

None

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SUBJECT OBJECTIVES

C1 Gain the skills for preparing a presentation allowing students in communicative way transfer their original ideas, concepts and solutions contained in in the final project

C2 Possess the skills of creative discussion allowing in a factual and substantive way justified and defended own opinions

SUBJECT EDUCATIONAL EFFECTS

relating to skills:

PEU_U01 is able to prepare a presentation that contains own scheme of research based on references.
PEU_U02 is able to prepare a presentation that contains the results of research being a part of his/her master thesis.
PEU_U03 is able to critically evaluate the scientific and technical issues of other presentations, and to justify and to defend own opinions.

Form of classes - seminar		**Number of hours**
Sem1	Discussion of the principles of preparing and writing a Master Thesis, including the principles of editorial side of the final project.	3
Sem2	The first round of presentations - Individual presentation related to the problem of the thesis, pointed on the original own contribution in comparison to the achievements known in literature.	12
Sem3	Preparing to the final exam – rules, question and answers.	3
Sem4	The second round of presentations - Individual presentations summarizing the results obtained in the final projects, in particular showing the selected topics and objectives of the diploma thesis outlining the original approach proposed by the author.	12
	Total hours	**30**

TEACHING TOOLS USED

N1. Multimedia presentation
N2. Discussion - talk problematic
N3. Literature studies
N4. 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_U01, PEU_U03	Assessment of the first presentation, the activity in the discussion, keeping deadlines.
F2	PEU_U02, PEU_U03	Assessment of the second presentation, the activity in the discussion, quality assessment of final project results.
P = 0.4*F1 + 0.6*F2		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Literature related to the issues of the diploma thesis
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Prof. Michał Woźniak, michal.wozniak@pwr.edu.pl

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Attachment no. 4. to the Program of Studies

FACULTY **Faculty of Information and Communication Technology**

SUBJECT CARD

Name of subject in Polish: Projekt badawczy
Name of subject in English: Research Project
Main field of study (if applicable): Computer Engineering
Specialization (if applicable): Advanced Computer Science
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: optional
Subject code: W04ITE-SM4246P
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)				45	
Number of hours of total student workload (CNPS)				75	
Form of crediting				Crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points				3	
including number of ECTS points for practical classes (P)				3	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				2,28	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1 Acquiring the ability to design and implement a system simulating a real optimization problem.
C2. Acquiring the ability to conduct simulation research in accordance with the multi-stage plan of the experiment
C3 Acquiring the ability to analyze and document simulation results

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

relating to skills:
PEU_U01 is able to implement algorithms for the needs of a complex optimization problem
PEU_U02 is able to carry out simulation tests according to the developed multi-stage experiment plan

PEU_U03 is able to develop and present the analysis of simulation test results in the form of a written report

relating to social competences:

PEU_K01 understands the necessity to work in a group in the implementation of a complex project task by performing assigned tasks in accordance with the assumed work schedule

PEU_K02 can use literature sources and select materials available on the Internet

PROGRAMME CONTENT

	Project	**Number of hours**
Proj 1	Organizational matters, including the establishment of project groups. Discussion and agreement on the subject of projects1) in IT - Assignment of design tasks concerning the comparison of algorithms solving a selected optimization problem	6
Proj 2	Preparation of a Gantt chart for the purposes of scheduling project implementation	3
Proj 3	Implementation of design tasks in accordance with the adopted schedule - presenting the status of the project to the leader.	20
Proj 4	Development of project documentation in writing (including results sample tests). Discussion. Verification of projects - execution of possible corrections.	10
Proj 5	Presentation of the final project documentation. Assessment of the implementation of tasks design.	6
	Total hours	45

TEACHING TOOLS USED

N1. Problem discussion
N2. Consultations
N3. 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_K01, PEU_K02	Activity on the subject, assessment of group cooperation
F2	PEU_U01,PEU_U02, PEU_U03	evaluation of completed design tasks, evaluation of a written report on the project
P = 0,25 * F1 + 0,75 * F2, with condition: [(F1 ≥ 3.0) ∧ (F2 ≥ 3.0)]		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Cormen Thomas H., Leiserson Charles E., Rivest Ronald L, Clifford Stein "Wprowadzenie do algorytmów" Wydawnictwo Naukowe PWN 2020
[2] Omid Bozorg-Haddad, Mohammad Solgi, Hugo A. Loáiciga "Meta-heuristic and Evolutionary Algorithms for Engineering Optimization", Wiley 2017
[3] D.C. Montgomery, „Design and Analysis of Experiments", 2012

SECONDARY LITERATURE:

Scientific papers - IEEE Xplore, Google Scholar etc.

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

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Attachment no. 4. to the Program of Studies

FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish	**:**	Modelowanie i optymalizacja sieci komputerowych
Name of subject in English	**:**	Modeling and Optimization of Computer Networks
Main field of study (if applicable)	**:**	Computer Engineering
Specialization (if applicable)	**:**	Advanced Computer Science
Profile	**:**	academic
Level and form of studies	**:**	2nd level, full-time
Kind of subject	**:**	optional
Subject code	**:**	W04ITE-SM4247G
Group of courses	**:**	YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			30	15
Number of hours of total student workload (CNPS)	40			75	35
Form of crediting	Examination			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 classes (P)	-			3	1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,84			1,52	0,68

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1. Knowledge in the field of application of computer networks and in the field of modeling, design and optimization of computer network.
C2. Competence of formulation, solving and presentation of design and optimization problems related to computer networks.
C3. Acquisition and consolidation of social competencies involving the need for statistical methods for the analysis of experimental data

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 – student has knowledge in the field of computer network applications.

PEU_W02 – student has knowledge of computer network standards.

PEU_W03 – student has knowledge of modeling, design and optimization of computer network.

relating to skills:

PEU_U01 – student can search information related to operation, modeling, design and optimization of computer network.

PEU_U02 – student can formulate computer network optimization problems

PEU_U03 – student can solve computer network optimization problems

PEU_U04 – student can present research results

relating to social competences:

PEU_K01 – student recognizes the need to use statistical methods for the analysis of experimental data in computer network optimization problems

PROGRAMME CONTENT

Form of classes - lecture		**Number of hours**
Lec 1	Introduction.	2
Lec 2	Optimization methods.	2
Lec 3	Multicommodity flows.	2
Lec 4	Capacity and flow assignment problems.	2
Lec 5	Anycast and multicast flows.	2
Lec 6	Network fragmentation.	3
Lec 7	Survivable networks.	2
	Total hours	15

Form of classes - project		**Number of hours s**
Proj 1	Literature analysis in selected topic related to computer networks.	4
Proj 2	Formulation of a research problem related to modeling and optimization of computer networks.	4
Proj 3	Development of a solution method.	4
Proj 4	Analysis of implementation environments.	2
Proj 5	Implementation of the solution method.	6
Proj 6	Experiments.	4
Proj 7	Evaluation of results.	2
Proj 8	Final report	2
Proj 9	Presentation of the final report.	2
	Total hours	30

Form of classes - seminar		Number of hours
Sem 1	Presentation of a research problem related to modeling and optimization of computer networks including literature survey, discussion.	4
Sem 2	Presentation of a solution method for a research problem related to modeling and optimization of computer networks, discussion.	4
Sem 3	Presentation of results and conclusions obtained according to research problem related to modeling and optimization of computer networks, discussion.	7
	Total hours	15

TEACHING TOOLS USED

N1. Lecture with multimedia presentations.

N2. Problem-oriented lecture

N3. Discussion

N4. Consultation

N5. Presentation - seminar

N6. Own work – preparation to lecture, seminar and project.

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	Tests, oral answers
F2	PEU_U01 ÷ PEU_U03, PEU_K01	Project work, presentation of project, participation in discussion
F3	PEU_U04	Seminar presentation, participation in discussion
P = 0,33F1 + 0,33F2 + 0,33F3, concluding grade may be passive subject to all F1 – F3 are passive		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] K. Walkowiak, *Modeling and Optimization of Computer Networks*, Textbook, Wroclaw University of Technology, 2011

[2] M. Pióro, D. Medhi, „Routing, Flow, and Capacity Design in Communication and Computer Networks", Morgan Kaufman Publishers 2004

[3] A. Kasprzak, „Rozległe sieci komputerowe z komutacją pakietów", Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 1997

[4] W. Grover, „Mesh-based Survivable Networks: Options and Strategies for Optical, MPLS, SONET and ATM Networking", Prentice Hall PTR, Upper Saddle River, New Jersey, 2004

[5] Walkowiak K., Modeling and Optimization of Cloud-Ready and Content-Oriented Networks, Studies in Systems, Decision and Control, Vol. 56, Springer Verlag, 2016

SECONDARY LITERATURE:

[1] Standards RFC (ang. Request for Comments) IETF (ang. Internet Engineering Task Force) www.ietf.org

[2] Standardy organizacji IEEE (ang. Institute of Electrical and Electronics Engineers)

www.ieee.org
[3] R. K. Ahuja, T. L. Magnanti, and J. B. Orlin. *Network Flows: Theory, Algorithms, and Applications,* Prentice Hall, 1993
[4] Web site J. B. Orlin http://web.mit.edu/jorlin/www/
[5] J. Vasseur, M. Pickavet, P. Demeester, *Network Recovery, Protection and Restoration of Optical, SONET-SDH, IP, and MPLS*, Elsevier, 2004
[6] L. Ford, D Fulkerson, Przepływy w sieciach, PWN, Warszawa 1969
[7] Hofmann M. and Beaumont L., Content networking: architecture, protocols, and practice, Morgan Kaufmann, San Francisco, 2005
[8] Minoli D. , IP Mulitcast with Applications to IPTV and Mobile DVB-H, John Wiley & Sons, 2008
[9] Research papers

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Attachment no. 4. to the Program of Studies

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

SUBJECT CARD

Name in Polish: Zarządzanie informacją i pamięciami masowymi
Name in English: Information and Storage Management
Main field of study (if applicable): Computer Engineering
Specialization (if applicable): Advanced Computer Science
Level and form of studies: 2nd level, full-time
Kind of subject: optional
Subject code W04ITE-SM4248G
Group of courses YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		15		
Number of hours of total student workload (CNPS)	25		25		
Form of crediting	crediting with grade		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)	0,68		0,68		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.
2.
3.

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SUBJECT OBJECTIVES

C1 Acqusition of knowledge, supported with theory, about methods, techniques, protocols and tools utilized in storage networking and information management
C2 Acqusition of skills related to the design of storage networking solutions and information management

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 Knows physical and logical components of a storage infrastructure and storage networking technologies
PEU_W02 Can describe information security and business continuity requirements and solutions, and identify parameters for managing and monitoring storage infrastructure

relating to skills:
PEU_U01 Can design, configure and manage selected networking storage solutions

PEU_U02 Can utilize mechanisms ensuring business continuity

PROGRAMME CONTENT		
Lecture		**Number of hours**
Lec 1	Introduction to information storage	2
Lec 2	Data Center Infrastructure	2
Lec 3	Intelligent Storage Systems	1
Lec 4	Block-based Storage System	1
Lec 5	File-based, Object-based and Unified Storage System	1
Lec 6	Software-defined Storage	1
Lec 7	Fibre Channel SAN, Internet Protocol SAN	2
Lec 8	Introduction to Business Continuity	1
Lec 9	Backup, Archive and Replication	2
Lec 10	Securing the Storage Infrastructure	1
Lec 11	Managing the Storage Infrastructure	1
	Total hours	**15**

Laboratory		**Number of hours**
Lab 1	Introduction to laboratory classes. Familiarization with laboratory equipment	2
Lab 2	Storage system – installation, authentication configuration	2
Lab 3	Storage system –NAS shares configuration	2
Lab 4	SAN configuration	4
Lab 5	Configuration of storage infrastructure elements	2
Lab 6	Configuration of selected business continuity mechanisms	3
	Total hours	**15**

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_U02	Laboratory reports
F3		
P = 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] 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] Nigel Poulton, Data Storage Networking: Real World Skills for the CompTIA Storage+ Certification and Beyond, Sybex 2014
[2] http://education.emc.com/academicalliance
[3] Computerworld magazine

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

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Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

SUBJECT CARD

Name of subject in Polish:	**Sieci Neuronowe**
Name of subject in English:	**Neural Networks**
Main field of study (if applicable)	**Computer Engineering**
Specialization (if applicable)	**Advanced Computer Science**
Profile:	**academic**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	**W04ITE-SM4249G**
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)	75			75	
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 classes (P)	–			3	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.36			1,52	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Ability to conduct literature study.
2. Basic *Python* programming skills.

SUBJECT OBJECTIVES

C1. Acquiring knowledge of basic issues related to artificial neural networks and deep networks.
C2. Acquiring knowledge related to learning methods and selection of optimal structures of neural networks.
C3. Acquiring the ability to use neural networks in practical applications using the *PyTorch* library in the *Python* programming language.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01. Has basic knowledge of linear classifiers, with particular emphasis on the logistic regression algorithm.
PEU_W02. Knows selected architectures of artificial neural networks and their components.
PEU_W03. Knows the procedure of learning artificial neural networks using the backpropagation algorithm.
PEU_W04. Has basic knowledge of deep learning and its regularization methods.
PEU_W05. Knows the use of selected types of deep neural networks in practical tasks regarding the classification of digital signals and data augmentation.
PEU_W06. Knows the basics of the semi-supervised and self-supervised learning in the contexts of deep learning-based pattern recognition systems.

relating to skills:
PEU_U01. Can – using the *PyTorch* library and the *Python* language – implement elements of an IT system employing classification algorithms based on neural networks.
PEU_U02. Can use the known programming tool to obtain and process a selected type of data (tabular or signal).
PEU_U03. Can carry out comparative experimental research and support the obtained results with statistical analysis.
PEU_U04. Can indicate the application of selected neural network architectures in real classification problems.

relating to social competences:
PEU_K01. Recognizes the possibilities of using neural networks in solving decision problems.
PEU_K02. Understands the necessity of teamwork to formulate project assumptions, its implementation as well as analysis and discussion of the obtained results.

PROGRAMME CONTENT		
Lecture		**Number of hours**
Lec 1	Introduction and historical outline.	2
Lec 2	Linear classifiers - logistic regression, gradient descent, and stochastic gradient.	2
Lec 3	An artificial neural network as a classifier ensemble - artificial neuron, perceptron and a review of the most important architectures.	2
Lec 4	Training multilayer unidirectional neural networks - hyperparameters of neural networks and backpropagation algorithm.	4
Lec 5	Introduction to deep learning.	2
Lec 6	Regularization techniques in deep learning.	2
Lec 7	Recurrent neural networks - Long short-term memory architecture and its application using the *PyTorch* library.	2
Lec 8	Convolutional neural networks and their application in the classification of the digital signals using the *PyTorch* library.	4
Lec 9	Generative models and their application in data augmentation using the *PyTorch* library - Generative Adversarial Networks.	4

Lec 11	Semi-supervised and self-supervised learning methods for deep learning.	2
Lec 10	Current deep learning trends.	4
	Total hours	30

Project		**Number of hours**
Proj 1	Introduction.	2
Proj 2	Selection of the scope and topic of the project.	4
Proj 3	Conducting literature studies on a selected topic related to artificial neural networks.	6
Proj 4	Establishing project set-up.	4
Proj 5	Implementation of the experimental environment.	6
Proj 6	Results and statistical analysis.	6
Proj 7	The final version of the project and discussion.	2
	Total hours	30

TEACHING TOOLS USED
N1. Lecture with the use of a multimedia presentation. N2. Consultations. N3. Discussion. N4. Self-learning - preparing the project. N5. Self-learning - preparation for the lecture exam.

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	Test. conversation with a student.
F2	PEU_U01– PEU_U04, PEU_K01, PEU_K02	Evaluation of the project milestones and final report, discussion on the project.
P = 0.5*F1+0.5*F2. The final grade may be passing, provided that F1 and F2 are passing.		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Aggarwal, C.C., 2018. *Neural networks and deep learning.* Springer, 10, pp.978-3.

[2] Bishop, C., 1995. *Neural Networks for Pattern Recognition*. Oxford: University Press.

SECONDARY LITERATURE:

[1] Deisenroth, M. P., Faisal, A. A., & Ong, C. S. (2020). *Mathematics for machine learning*. Cambridge University Press.

[2] Chollet, F., 2017. *Deep learning with Python*. Simon and Schuster.

[3] Géron, A., 2019. Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems. O'Reilly Media.

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

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Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

SUBJECT CARD

Name of subject in Polish: Uczenie Maszyn
Name of subject in English: Machine Learning
Specialization (if applicable): Computer Engineering
Specialization (if applicable): Advanced Computer Science
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: optional
Subject code: W04ITE-SM4250G
Group of courses: YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		15	15	
Number of hours of total student workload (CNPS)	60		45	45	
Form of crediting	Exam		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			1,5	1,5	
including number of ECTS points for direct teacher-student contact (BK) classes	1,52		0,68	0,76	

PREREQUISITES RELATING TO KNOWLEDGLE, SKILLS AND OTHER COMPETENCES

Ability to analyze related works and basic programming skills in Python.

SUBJECT OBJECTIVES

C1 Acquiring knowledge of the basic issues of machine learning.
C2. Acquiring knowledge about designing artificial intelligence systems with the use of machine learning algorithms.
C3 Acquiring knowledge and skills in the implementation and optimization of algorithms and recognition models.
C4. Mastering the ability to reliably conduct scientific research in the field of artificial intelligence.

SUBJECT LEARNING OUTCOMES

Relating to knowledge:
PEU_W01 Student has basic knowledge of machine learning terminology and taxonomy.
PEU_W02 Student has knowledge of selected methods of construction of recognition models
PEU_W03 Student knows selected algorithms and tools used to implement artificial intelligence models.
PEU_W04 Student knows selected methods of feature extraction from numerical data.
PEU_W05 Student has knowledge of unsupervised learning methods for supporting supervised learning methods.
PEU_W06 Student has knowledge of the reliable design of machine learning experiments and statistical testing.
PEU_W07 Student knows the methods of integration of ensemble systems.

Relating to skills:
PEU_U01 Student can design elements of AI system using the pattern recognition methods.
PEU_U02 Student can use the known programming tools to obtain and process numerical data with the use of selected pattern recognition techniques
PEU_U03 Student can design and conduct an experimental evaluation to assess the quality of selected artificial intelligence models supplemented with a statistical analysis of the obtained results
PEU_U04 Student can indicate the appropriate application of the known methods of artificial intelligence to solve real problems
PEU_U05 Student can use selected methods of pattern recognition for the construction of ensemble systems.

Relating to social competences:
PEU_K01 Student recognizes the possibilities of using machine learning techniques in rationalizing the use of time of domain experts.
PEU_K02 Student can use the acquired knowledge and skills to design commercial AI systems.
PEU_K03 Student can implement project tasks by fulfilling the duties assigned to him as a team member.

PROGRAMME CONTENT

Form of classes - lecture		**Number of hours**
Lec 1	Presentation of the rules, introducing basic terminology, taxonomy of pattern recognition methods and a historical outline of the field.	2
Lec 2	Classification task on the example of minimum distance methods. Dichotomy, prediction, support, quality assessment metrics for classification models.	2
Lec 3	Tools for conducting reliable experimental research in the field of machine learning. Cross-validation, learning process factors, hyperparameter optimization, statistical hypothesis testing.	4
Lec 4	Data pre-processing methods. Normalization (interval, standard, quantile), spatial reduction of sets (selection and extraction of attributes), strategies for supplementing missing values.	2

Lec 5	Regression problem on the example of linear regression methods. Metrics for assessing the quality of regression models, introduction to optimization learning methods on the example of logistic regression.	2
Lec 6	Clustering task based on the KMeans method. Metrics for assessing the quality of clustering models, auxiliary role of clustering in the classification task, semi-supervised learning.	2
Lec 7	Review of pattern recognition algorithms. Decision trees, support vector machines, multilayer perceptron, NB classifier.	6
Lec 8	Ensemble systems. Methods of diversifying the pool of classifiers, ensemble architecture, rules of pool integration.	2
Lec 9	Classification of imbalanced data.	2
Lec 10	Incremental learning and data stream processing. The phenomenon of concept drift, accumulative learning, active learning.	4
Lec 11	Redaction of research papers in the field of machine learning.	2
	Total hours	**30**

Form of classes - laboratory		**Number of hours**
Lab 1	Presentation of the rules, familiarization with the laboratory environment, introductory script verifying compliance with the prerequisites of the course.	1
Lab 2	Data loading, construction of recognition models, model quality reporting.	2
Lab 3	Cross-validation and statistical hypothesis testing.	2
Lab 4	Assessment of the impact of data preprocessing on the quality of models, optimization of hyperparameters.	2
Lab 5	Visualization of research results.	2
Lab 6	Implementation of scikit-learn estimators.	2
Lab 7	Construction of homogeneous classifier ensembles.	2
Lab 8	Methods of processing imbalanced data.	2
	Total hours	15

Form of classes - project		**Number of hours**
Proj 1	Presentation of the rules, establishing project groups, selection of a topic, familiarization with the project implementation schedule.	1
Proj 2	Elements of a scientific article.	1
Proj 3	How to reliably conduct literary studies?	2
Proj 4	How to reliably describe the pattern recognition algorithm?	2
Proj 5	How to reliably describe the data and the experimental protocol?	4
Proj 6	How to reliably present research results?	4
Proj 7	Final design work.	2
	Total hours	15

TEACHING TOOLS USED
N1. Lecture with the multimedia presentation N2. Consultation. N3. Discussion of a given problem. N4. Supplementary materials. N4. Self-learning – preparing projects, reports, to lecture or lab

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes number	Way of evaluating learning outcomes achievement
F1	PEU_W01 - PEU_W07	Exam (test or oral).
F2	PEU_U01 - PEU_U03	Evaluation of each laboratory meeting, laboratory report, discussion on the chosen task related to laboratory.
F3	PEU_U04 - PEU_U05 PEU_K01 - PEU_K03	Evaluation of the project milestones and final report, discussion on project.
P = F1/2 + F2/4 +F3/4, concluding grade may be passing subject to all F1 – F3 are passing		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020. Hart, Peter E., David G. Stork, and Richard O. Duda. Pattern classification. Hoboken: Wiley, 2000. Kuncheva, Ludmila I. Combining pattern classifiers: methods and algorithms. John Wiley & Sons, 2014. **SECONDARY LITERATURE:** Wozniak, Michal. Hybrid classifiers: methods of data, knowledge, and classifier combination. Vol. 519. Springer, 2013. Aggarwal, Charu C., ed. Data streams: models and algorithms. Vol. 31. Springer Science & Business Media, 2007.
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Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

SUBJECT CARD

Name of subject in Polish:	**Wstęp do przetwarzania obrazów i zastosowań w monitorowaniu jakości produkcji**
Name of subject in English:	**Introduction to Computer Vision in Quality Control**
Main field of study (if applicable):	**Computer Engineering**
Specialization (if applicable):	**Advanced Computer Science**
Profile:	**academic**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	**W04ITE-SM4251G**
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			65	
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 classes (P)	-			2,5	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,36			1,52	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1. Classification of cameras and their properties

C2. Gaining skills in selecting and creating algorithms and their sequences appropriate for solving a task.

C3. Gaining skills in writing computer codes for C2.

C4. Collecting skills that are necessary for designing and creating simple applications for processing image sequences.

C5. Collecting knowledge on methods of object detection by thresholding.

C6. Collecting knowledge on methods of object detection by finding their contours.

C7. Collecting knowledge on standard image filters

C8 Collecting knowledge on control charts for quality monitoring of industrial processes and their applications together with image processing algorithms.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 – has knowledge on types of cameras and their properties
PEU_W02 – knows basic rules of selecting a type of camera (infra-red, ultraviolet, day or artificial light cameras) and basic rules of selecting their parameters
PEU_W03 – has knowledge on basic methods of object detection from images
PEU_W04 – knows basic functional blocks of typical software for image processing
PEU_W05 – knows basic principles of contouring and thresholding
PEU_W06 – has basic knowledge on control charts and their applications in common with image processing
PEU_W07 – knows principles of image filtering methods
PEU_W08 – knows basic notions related to processing image sequences

relating to skills:

PEU_U01 – has the ability to design a collection of devices for image acquisition
PEU_U02 – has the skills to code simple algorithms of image processing
PEU_U03 – has the skills of selecting available image processing modules for solving complex problems arising in industrial image processing
PEU_U04 – has the ability to select control chart for a given industrial process as well as an image filter or other method of image enhancement
PEU_U05 – has the skills of investigating timings of blocks in codes for image sequence processing
PEU_U06 – is able to choose the image correction method
PEU_U07 – has the ability to select an image compression method for archiving images

relating to social competences:

Form of classes - lecture		**Number of hours**
Lec 1	The organization of classes, requirements and an overview of image processing applications	2
Lec 2	Image Sources, types of cameras, the selection and choice of parameters	2
Lec 3	Representations of images and noise, simple operations on images	2
Lec 4	Finding objects using different methods of segmentation	2
Lec 5, Lec 6	Methods of selecting threshold segmentation, analysis and characterization of clusters	3
Lec 6, Lec 7	Labelling clusters	3
Lec. 8	Finding objects using different methods of edge detection	2
Lec 9	Descriptors and detection of objects of known shapes - Hough transformation	2
Lec 10	Fast, coarse detection of objects and their location	2
Lec 11	Industrial applications – example	2
Lec 12	Image filtering and correction	2
Lec 13	Control charts for the mean value of the process, working with a vision system. Introduction to morphological image processing methods	2
Lec 14	Control charts for the frequency of defects and the variance of the	2

	process. Applications 2 - video sequences	
Lec 15	repertory	2
	Total hours	**30**

Form of classes - project		**Number of hours**
Proj 1	The organization of groups, discussion and selection of project topics	4
Proj 2	Presentation of the concept of the project by the project groups 1	4
Proj 3	Presentation of the concept of the project by the project groups 2	4
Proj 4	Individual consultations for project groups 1	4
Proj. 5	Individual consultations for project groups 2	4
Proj 6	Presentation of the project by the project groups 1	4
Proj. 7	Presentation of the project by the project groups 2	4
Proj. 8	Review	2
	Total hours	**30**

TEACHING TOOLS USED
N1. Traditional lectures using video projector N2. Project N3. Consulting N4 Homework on project N5 Homework – studies

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_W09 PEU_K01 - PEU_K02	Oral Answers to questions asked during the lecture, observations of the steps for implementing the project
F2	PEU_U01 - PEU_U06	written report on the project
C= 0,3*F1 + 0,7*F2, assuming F1 > 2.0 i F2 > 2.0		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Gonzales R. C., Woods R. E., Digital Image Processing,

2-nd ed., Prentice Hall 2002.

[2] E. Rafajłowicz, W. Rafajłowicz, Wstep do przetwarzania obrazów przemysłowych, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2011 (książka dostępna bezpłatnie na portalu Dolnoslaskiej Biblioteki Cyfrowej). (in Polish, slides available in English)

[3] Pod red. E. Rafajłowicza, W. Rafajłowicza, Algorytmy przetwarzania obrazów i wstęp do pracy z~biblioteką OpenCV. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2006 (książka dostępna bezpłatnie na portalu Dolnoslaskiej Biblioteki Cyfrowej). (in Polish)

[4] Pratt, W. K., Digital image processing, New York, Wiley, 1991.

[5] Thompson J.~R., Koronacki J., Statystyczne sterowanie procesem. Metoda Deminga etapowej optymalizacji jakości. Akademicka Oficyna Wydawnicza PLJ, Warszawa, 1994. (in Polish)

see also

Thompson J.~R., Koronacki J. Statistical process control for quality improvement, 2° ed**.**

Chapman and Hall NY, 2001

SECONDARY LITERATURE:

[1] Demant C., Streicher-Abel B. and P. Waszkewitz;
Industrial Image Processing: Visual Quality Control in

[2] Jahne B., Digital Image Processing,
5-th Edition, Springer 2002.

[3] Journals:

Real-Time Imaging

IEEE Transactions OnPattern Analysis and Machine Intelligence

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

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Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

SUBJECT CARD

Name of subject in Polish: **Przetwarzanie Języka Naturalnego**
Name of subject in English: **Natural Language Processing**
Main field of study (if applicable) **Computer Engineering**
Specialization (if applicable) **Advanced Computer ScienceControl**
Profile: **academic**
Level and form of studies: **2nd level, full-time**
Kind of subject: **optional**
Subject code **W04ITE-SM4252G**
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			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)	-			1	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,68			1,52	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Ability to do literature studies and basic programming skills in Python

SUBJECT OBJECTIVES

C1 To acquire knowledge in the scope of basic problems and techniques of natural language processing.
C2 To gain knowledge and skills in using methods for designing natural language processing systems augmented with the application of deep learning techniques.
C3 To gain knowledge and skills in applying pattern recognition and feature extraction methods to solve text data classification problems.
C4 To get acquainted with methods of experimental quality assessment of natural language processing algorithms and to acquire practical skills of designing and conducting computer experiments in a selected programming environment.

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:
PEU_W01 Student has basic knowledge about formal description of natural language.

PEU_W02 Student has knowledge about selected methods used to acquire, analyze and process text data
PEU_W03 Student knows selected algorithms and tools used to design computer systems for natural language processing
PEU_W04 Student knows selected methods of feature extraction from text data in natural language processing
PEU_W05 Student has knowledge on methods of supervised learning for the task of text classification
PEU_W06 Student has knowledge of applying deep learning techniques to selected natural language processing issues
PEU_W07 Student has knowledge on performing reliable experimental evaluation of selected methods of natural language processing and statistical analysis of obtained results

Relating to skills:
PEU_U01 Student is able to design elements of an information system using natural language processing methods.
PEU_U02 Student is able to use known programming tools to obtain and process text data using selected techniques of natural language processing
PEU_U03 Student is able to design and carry out experimental evaluation in order to assess the quality of selected methods of natural language processing, supplemented by statistical analysis of obtained results.
PEU_U04 Student is able to indicate adequate application of the recognized methods of natural language processing to solve real problems.
PEU_U05 Student is able to use selected methods of pattern recognition and deep learning to extract features from natural language, solve text classification problems and other applications of supervised learning.

Relating to social competences:
PEU_K01 Student recognizes the possibilities of using natural language processing techniques in designing information systems
PEU_K02 Student can in an entrepreneurial way use acquired knowledge and skills to design commercial natural language processing systems
PEU_K03 Student is able to perform design tasks in a team way by completing assigned duties in a team.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Introduction, pass requirements and class organization, historical background, basic concepts of natural language processing	1
Lec 2	An introduction to natural language processing, the various stages of the standard natural language processing workflow, and an overview of applications in various disciplines.	2
Lec 3	Text processing - methods of data extraction, sentence segmentation, text tokenization, practical examples	2
Lec 4	Classical approaches to natural language processing - analysis: lexical, syntactic, semantic	3
Lec 5	Statistical approaches to natural language processing - creating corpora, basics of statistical techniques, discussion of selected methods	2

Lec 6	Pattern recognition methods in text classification task, attribute extraction, sentence structure analysis.	3
Lec 7	Natural language processing using selected deep learning techniques	2
	Total hours	15

Project		**Number of hours**
Proj 1	Introduction, pass requirements and class organization, discussion on exemplary projects	2
Proj 2	Selection of the project scope and topic	4
Proj 3	Literature studies on selected methods of natural language processing	6
Proj 4	Development of a experiments' plan	4
Proj 5	Implementation of planned experimentss	8
Proj 6	Statistical analysis of the obtained results	4
Proj 7	Presentation of results and project reports - discussion	2
	Total hours	30

TEACHING TOOLS USED

N1. Lecture involving presentation
N2. Consultation
N3. Problem discussion
N4. Own work - project preparation, preparation for a 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_W07	Colloquium, verbal test.
F2	PEU_U01 - PEU_U05 PEU_K01 - PEU_K03	Evaluation of the project components and its final form, verbal answers.

P = 0.5 * F1 + 0.5 * F2. In order to receive a positive grade, it is necessary to successfully pass the lecture and the project.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Indurkhya, Nitin, and Fred J. Damerau, eds. Handbook of natural language processing. Vol. 2. CRC Press, 2010.
[2] Deng, Li, and Yang Liu, eds. Deep learning in natural language processing. Springer, 2018.
[3] Bird, Steven, Ewan Klein, and Edward Loper. Natural language processing with Python: analyzing text with the natural language toolkit. " O'Reilly Media, Inc.", 2009.
[4] Manning, Christopher, and Hinrich Schutze. Foundations of statistical natural language processing. MIT press, 1999.

SECONDARY LITERATURE:

[1] Eisenstein, Jacob. "Natural language processing." (2018).
[2] Hapke, Hannes, Cole Howard, and Hobson Lane. Natural Language Processing in Action: Understanding, analyzing, and generating text with Python. Simon and Schuster, 2019.
[3] Vajjala, Sowmya, et al. Practical Natural Language Processing: A Comprehensive Guide to Building Real-World NLP Systems. O'Reilly Media, 2020.

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

dr inż. Jakub Klikowski, jakub.klikowski@pwr.edu.pl

Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY **Faculty of Information and Communication Technology**

SUBJECT CARD

Name of subject in Polish Projekt badawczy 2
Name of subject in English Research Project 2
Main field of study (if applicable): Computer Engineering
Specialization (if applicable): Advanced Computer Science
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W04ITE-SM4253G
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)				50	50
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 classes (P)				2	2
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				0,76	1,36

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1 Acquiring the ability to present research results in the form of a scientific article, in particular taking into account editorial requirements.
C2. Acquiring the ability to prepare and deliver a paper at a scientific conference
C3 Gaining experience in preparing a scientific conference and performing different roles in the program committee and the organizing committee of the conference

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

relating to skills:

PEU_U01 is able to prepare a paper for a scientific conference in line with the editorial requirements
PEU_U02 is able to deliver a paper at a scientific conference and actively participate in the deliberations of a scientific conference
PEU_U03 is able to develop a program and organizational scenario for a scientific conference and organize one

relating to social competences:
PEU_K01 is able to work in a team in the organization of a scientific conference

PROGRAMME CONTENT

Project		**Number of hours**
Proj 1	Organizational matters	2
Proj 2	Acquainting with the principles of preparing scientific articles in English - article structure - discussion of the functions of the elements: Introduction, Related work, Problem statement, Solution - Algorithms, Experimentation system, Investigation, Analysis of results, Conclusion; Presentation and discussion of sample articles, discussion	2
Proj 3	Getting to know the editorial requirements and detailed rules of article formatting on the examples of well-known publishing houses in the field of computer science: IEEE, IFAC, Springer, Elsevier	2
Proj 4	Preparation of the final version of a scientific article. Final verification by the supervisor	9
	Total hours	15
Seminar		**Number of hours**
Semin 1	Organizational matters - rules for the preparation and presentation of conference papers	2
Semin 2	Organizational meetings of the ACS scientific conference - election of the chairman, members of the organizing/program committee.	6
Semin 3	Conducting a scientific conference of ACS students. Presentations of conference papers. Problem discussions at conference sessions.	20
Semin 4	Choosing the best presentations. Summary	2
	Total hours	30

TEACHING TOOLS USED

N1. Multimedia presentation
N2. Problem discussion
N3. Design task
N4. Written report
N5. 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_K01, PEU_U02	Activity on the subject, evaluation of the presentation at the scientific conference
F2	PEU_U01,PEU_U03	Assessment of the conference article, assessment of the organizational level of a scientific conference
P = 0,5 * F1 + 0,5 * F2, with condition: [(F1 ≥ 3.0) ∧ (F2 ≥ 3.0)]		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Cormen Thomas H., Leiserson Charles E., Rivest Ronald L, Clifford Stein "Wprowadzenie do algorytmów" Wydawnictwo Naukowe PWN 2020

[2] Omid Bozorg-Haddad, Mohammad Solgi, Hugo A. Loáiciga "Meta-heuristic and Evolutionary Algorithms for Engineering Optimization", Wiley 2017

[3] D.C. Montgomery, „Design and Analysis of Experiments", 2012

[4] Websites of leading scientific conferences

SECONDARY LITERATURE:

Scientific papers - IEEE Xplore, Google Scholar etc.

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

Wojciech Kmiecik, PhD, e-mail: wojciech.kmiecik@pwr.edu.pl

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY Information and Communication Technology

SUBJECT CARD

Name of subject in Polish **KOMUNIKACJA SPOŁECZNA**
Name of subject in English **SOCIAL COMMUNICATION**
Main field of study (if applicable) Computer Engineering
Specialization (if applicable): -
Profile: **academic**
Level and form of studies: **2nd level, full-time**
Kind of subject: **obligatory**
Subject code **W08W04-SM4002**
Group of courses **NO**

	Lecture	Exercise	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)					15
Number of hours of total student workload (CNPS)					50
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 classes (P)					1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)					0,68

*delete where not applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. No prerequisites

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SUBJECT OBJECTIVES

C1 Familiarizing students with expanded knowledge relating to social communication as a key social process
C2. Students' mastery of the ability to observe and analyze social life in the aspect of communication

OBJECTIVE EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Knows and understands the economic, legal, etic and other conditions of undertaking various types of activities relating to the awarded qualification, including regulations on industrial property rights and copyrights
PEU_W02 Knows and understands the basic principles of creation and development of various forms of entrepreneurship
PEU_W03 Knows and understands the fundamental dilemmas of modern civilization

relating to Skills:

PEU_U01 Is able to apply the knowledge that they have learned to formulate and solve complex and non-routine problems as well as innovatively carry out tasks under unpredictable conditions by:

- properly selecting sources and information from them; conducting an assessment, critical analysis, synthesis and creative interpretation and presentation of this information,
- selecting and using proper methods and tools, including advanced techniques of information communications technology (ICT)
- adapting existing or developing new methods and tools

PEU_U02 Is able to lead debates
PEU_U03 Is able to direct the work of a team
PEU_U04 Is able to interact with others in teamwork and take a leading role in teams
PEU_U05 Is able to autonomously plan and implement personal lifelong learning and direct others in this area

relating to social competences:

PEU_K01 Is ready to think and act in an enterprising manner

PROGRAM CONTENT

Seminar		Number of hours
Semin1	Characteristics of social communication	2
Semin2	Practical forms: verbal communication	2
Semin3	Practical forms: non-verbal communication	2
Semin4	Communication in the organization: practical aspects	2
Semin5	Public speaking: preparation and implementation	2
Semin6-7	Mass communication	4
Semin8	Summary and passing	1
	Total hours	15

TEACHING TOOLS USED
N1. Introductory information N2. Discussion N3. Presentation

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_U02 PEU_U03 PEU_U04	Discussion activity
F2	PEU_W01 PEU_W02 PEU_W03 PEU_U02 PEU_U03 PEU_U04 PEU_U05	Presentation
F3	PEU_U02 PEU_U03 PEU_U04 PEU_K01	Working in groups
P= (F1+F2+F3)/3		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] M. Castells, *Społeczeństwo sieci*, Warszawa 2007
[2] B. Dobek-Ostrowska, *Podstawy komunikowania społecznego*
[3] T. Goban-Klas, *Media i komunikowanie masowe. Teorie i analizy prasy, radia, telewizji i Internetu*, Warszawa-Kraków 1999
[4] D. G. Leathers, *Komunikacja niewerbalna. Zasady i zastosowanie*, Warszawa 2007
[5] A. i B. Pease, *Mowa ciała*, Poznań 2010
[6] A. Wiszniewski, *Jak przekonująco mówić i przemawiać*, Wrocław-Warszawa 1996

SECONDARY LITERATURE:

[1] S. P. Morreale, B.H. Spitzberg, J. Barge, *Komunikacja między ludźmi: motywacja, wiedza, umiejętności*, Warszawa 2015
[2] A. Postawa, *Medialne ®ewolucje a komunikowanie społeczne*, Toruń 2020
[3] H. Rheingold, *Narzędzia ułatwiające myślenie. Historia i przyszłość metod poszerzania możliwości umysłu*, Warszawa 2003
[4] C. Stuart, *Sztuka przemawiania i prezentacji*, Warszawa 2002

[5] J.B. Thompson, *Media i nowoczesność. Społeczna teoria mediów*, Wrocław 2006
SUBJECT SUPERVISOR (NAME, SURNAME, E-MAIL ADDRESS)
dr hab. Zdzisław Ilski (e-mail:zdzislaw.ilski@pwr.edu.pl). The course is also attended by: Dr. Jerzy Kordas (e-mail: pwr.edu.pl), Dr. Andrzej Postawa (e-mail: andrzej.postawa@pwr.edu.pl)

Załącznik nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

SUBJECT CARD

Name of subject in Polish: **Przedsiębiorczość**
Name of subject in English: **Entrepreneurship**
Main field of study (if applicable): **Computer Engineering**
Specialization (if applicable):
Profile: **academic**
Level and form of studies: **2nd level, full-time**
Kind of subject: **optional / university-wide**
Subject code: **W08W04-SM4006**
Group of courses: **YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	**15**				**15**
Number of hours of total student workload (CNPS)	**38**				**37**
Form of crediting (Examination / 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					**1,5**
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	**0,68**				**0,68**

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1 Obtaining knowledge about strategic entrepreneurship
C2 Knowing instruments (strategies, models and methods), that support strategic entrepreneurship

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:
PEU_W01 Student knows the idea of entrepreneurship and innovativeness
PEU_W02 Student knows types of entrepreneurship and innovations
PEU_W03 Student is familiarity with selected instruments (concepts, methods, models) of estimation an entrepreneurship and innovations

Relating to skills:
PEU_U01 Student is able to seek and interpret the knowledge of entrepreneurship and innovativeness

Relating to social competences:
PEU_K01 Student acquires enthusiastic and entrepreneurial approach for activity and skills in the field of innovation

PROGRAMME CONTENT		
Form of classes – lecture		**Number of hours**
Lec 1	Introduction to entrepreneurship	3
Lec 2	Academic entrepreneurship	2
Lec 3	Corporate entrepreneurship and SME entrepreneurship	2
Lec 4	Regional entrepreneurship	2
Lec 5	Social entrepreneurship	2
Lec 6	Intellectual entrepreneurship	2
Lec 7	Test	2
	Total hours	15

Form of classes – seminar		**Number of hours**
Sem 1	Introduction to seminar	1
Sem 2	Characteristic of innovative idea/ product	2
Sem 3	Characteristic of customer client, competitor	2
Sem 4	Innovative idea/ product strategy	2
Sem 5	Success assessment/ Intellectual property	2
Sem 6	Financing innovation	2
Sem7	Business model	2
Sem8	Analyzing results of term work	2
….	Total hours	15

TEACHING TOOLS USED
N1 Laptop N2. Multimedia performance N3. Selected statistical data 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, PEU_W03, PEU_U01,	Estimation the student activity by checking list of presence (lecture)
F2	PEU_W01, PEU_W02, PEU_W03, PEU_UO1	Estimation the knowledge by preparing term work relating to entrepreneurship
F3	PEU_K01	Assessment of entrepreneurial approach by preparing the innovative idea/ product
P = 1/3*F1 + 1/3*F2 +1/3*F3		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] W. Kasprzak, K. Pelc, Innowacje. Strategie techniczne i rozwojowe, Wydawnictwo Politechniki Wrocławskiej, Wrocław, 2012

[2] G. Gierszewska, B. Olszewska, J. Skonieczny, Zarządzanie strategiczne dla inżynierów, PWE, Warszawa 2012

[3] J. Skonieczny (red.), Kształtowanie zachowań innowacyjnych, przedsiębiorczych i twórczych w edukacji inżyniera, Wydawnictwo Indygo Zahir Media, Wrocław, 2011

[4] P. Drucker, Natchnienie i fart czyli innowacja i przedsiębiorczość, Wydawnictwo Studia Emka, Warszawa 2004

[5] A. Dereń, Zarządzanie własnością intelektualną w transferze technologii, Difin, 2014.

SECONDARY LITERATURE:

[1] K. Matusiak (red.), Innowacje i transfer technologii. Słownik pojęć, PARP, Warszawa 2005

[2] A. Sosnowska, S. Łobejko, A. Kłopotek, J. Brdulak, A.Rutkowska-Brdulak, K.Zbikowska, Jak wdrażać innowacje technologiczne w firmie, PARP, Warszawa 2005

[3] J.G. Wissema, Technostarterzy. Dlaczego i jak?, PARP, Warszawa 2005

[4] A. Bąkowski, T. Cichocki, G. Gromada, J. Guliński, S. Kmita, T. Krzyżyński, U. Marchlewicz, K. Matusiak, D. Trzmielak, J. Wajda, K. Zasiadły, Innowacyjna przedsiębiorczość akademicka, PARP, Warszawa 2005

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

PhD Jan Skonieczny (jan.skonieczny@pwr.wroc.pl),

Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY Information and Communication Technology

SUBJECT CARD

Name of subject in Polish	**Praca dyplomowa**
Name of subject in English	**Diploma thesis**
Main field of study:	**Computer Engineering**
Specialization:	**Internet Engineering**
Profile:	**academic**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	**W04ITE-SM4113**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)				12	
Number of hours of total student workload (CNPS)				275	
Form of crediting (Examination / crediting with grade)				crediting with grade	
For group of courses mark (X) final course				X	
Number of ECTS points				11	
including number of ECTS points for practical classes (P)				11	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				1,84	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1 Acquiring the ability to formulate a research task in the area of computer engineering and plan own research experiments

C2 Acquiring the ability to conduct research, analyze and develop the results and prepare a master's thesis

SUBJECT EDUCATIONAL EFFECTS

relating to skills:

PEU_U01 Is able to formulate a research task in the field of computer engineering and prepare scenarios of research experiments

PEU_U02 Is able to obtain information from literature, documentation, databases and other sources

PEU_U03 Is able to complete a diploma thesis in the form of research work in the field of computer engineering

relating to social competences:

PEU_K01 Is able to critically evaluate existing and own scientific and technical solutions

PROGRAMME CONTENT		
Project		**Number of hours**
Proj 1	Analysis of the state of knowledge and technology in the area of the diploma thesis, review of research works on similar topics.	2
Proj 2	Formulation of the research task, specification of requirements.	2
Proj 3	Design and implementation of a research environment	4
Proj 4	Implementation of experiments, analysis of research results Preparation of research results and conclusions	4
	Total hours	12

TEACHING TOOLS USED
N1. Consultations N2. Problem oriented discussion N3. 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_U01- PEU_U03, PEU_K01	Evaluation of prepared diploma thesis
P=F1		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE:
[1] Literature agreed with the diploma thesis supervisor
[2] Technical documentation of the tools and technologies used
SECONDARY LITERATURE:
[1] Thesis recommendations – available on faculty web page
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
prof. dr hab. inż. Czesław Smutnicki, czeslaw.smutnicki@pwr.edu.pl

Załącznik nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY INFORMATION AND COMMUNICATION TECHNOLOGY

SUBJECTCARD

Name of subject in Polish	**:**	Fizyka
Name of subject in English	**:**	Physics
Main field of study (if applicable)	**:**	Computer Engineering
Specialization (if applicable)	**:**	……..
Profile	**:**	academic
Level and form of studies	**:**	2nd level, full-time
Kind of subject	**:**	obligatory
Subject code	**:**	W11ITE-SM4001
Group of courses	**:**	NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15				
Number of hours of total student workload (CNPS)	25				
Form of crediting (Examination / crediting with grade)	Crediting with grade				
For group of courses mark (X) final course					
Number of ECTS points	1				
including number of ECTS points for practical classes (P)	-				
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,68				

PREREQUISITIES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCIES

SUBJECT OJECTIVES

C1 Acquire a knowledge of selected, fundamental modern physics laws necessary for understanding physical phenomena within studied field

C2 Understanding the need for self-education.

THE SUBJECT EDUCATIONAL EFFECTS
Related to knowledge:
PEU_W01 knows and understands the wave-particle duality of electromagnetic radiation and matter
PEU_W02 knows and understands postulates and basic formalism of quantum mechanics
PEU_W03 knows and understands the meaning of the Schrödinger equation and a wave function
PEU_W04 knows and understands the meaning of the Schrödinger equation solutions for the hydrogen atom and many-electrons atoms.
PEU_W05 knows and understands the ideas of quantum description of polyatomic systems, in particular the band structure of crystals.
PEU_W06 knows and understands the effect of quantum statistics on properties of matter
PEU_W07 knows and understands how it is possible to explain the electro-optical properties of solids on the ground of band structure
PEU_W08 knows and understands the rules of operation of chosen modern electronic devices

PROGRAMME CONTENT		
Lecture		**Number of hours**
Wy1	Wave-particle duality of electromagnetic radiation and matter. Planc's law. De Broglie postulate.	2
Wy2	Postulates of quantum mechanics. Wave function. Heisenberg uncertainty principle.	2
Wy3	Schrödinger equation and its applications (quantum well, systems of quantum wells, quantum tunneling). Scanning tunneling microscope.	2
Wy4	Hydrogen atom. Quantum numbers. Spin. Many electron atoms. Absorption and emission spectra.	2
Wy5	Many atom systems. Types of ionic bonds. Crystalline structure. Electronic bands of crystals.	2
Wy6	Quantum statistics: Fermi-Dirac and Bose-Einstein.	2
Wy7	Electro-optical properties of dielectrics, semiconductors and metals within the picture of electronic bands.	2
Wy8	Chosen modern semiconductor devices (solar cell, photodiode, light emitting diode, semiconductor laser).	1
	Total hours	**15**

TECHING TOOLS USED
N1 Traditional and multimedia lecture presentations supplemented with the demonstration of physical phenomena
N2 E-lecture materials available in internet.
N3 Consultations and contact via e-mail.
N4 Own work – preparation to final test

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation of grade (F – forming, during semester, P – concluding, at the end of semester)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01,PEU_W02, PEU_W03,PEU_W04, PEU_W05,PEU_W06, PEU_W07,PEU_W08, PEU_K01, PEU_K02	activity on the lecture: oral answers and tests
F2	PEU_W01,PEU_W02, PEU_W03,PEU_W04, PEU_W05,PEU_W06, PEU_W07,PEU_W08, PEU_K01, PEU_K02	final test
P = F2 taking into account F1		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Materiały do wykładu (pliki PPT), dostępne poprzez internet: www.if.pwr.wroc.pl\~popko
[2] J. Orear, *Fizyka*, tom 2., WNT, Warszawa 2008.
[3] K.Sieranski, J.Szatkowski *Fizyka. Wzory i Prawa z Objaśnieniami* cz.III, Scripta 2008

SECONDARY LITERATURE:

[1] Paul A. Tipler *Fizyka Współczesna*; PWN, Warszawa 2011

[2] R R. A. Serway, *Physics for Scientists and Engineers*, 8th Ed., Brooks/Cole, Belmont 2009; *Physics for Scientists and Engineers with Modern Physics,* 8th Ed., Brooks/Cole, Belmont 2009

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

Paweł Scharoch, e-mail: pawel.scharoch@pwr.edu.pl
prof. dr hab. inż. Paweł Machnikowski; Pawel.Machnikowski@pwr.edu.pl

Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

SUBJECT CARD

Name of subject in Polish	**Zarządzanie projektem teleinformatycznym**
Name of subject in English	**Computer Project Management**
Main field of study (if applicable)	**Computer Engineering**
Specialization (if applicable)	**-**
Profile:	**academic**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code	**W04ITE-SM4010**
Group of courses	**YES / ~~NO*~~**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		15		15
Number of hours of total student workload (CNPS)	60		40		25
Form of crediting (Examination / crediting with grade)	Exam		Pass with grade		Pass with grade
For group of courses mark (X) final course	X				
Number of ECTS points	**5**				
including number of ECTS points for practical classes (P)			1,5		1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,52		0,68		0,68

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1 Familiarization with methods of documenting requirements
C2 Familiarization with selected project management methods
C3 Acquiring the ability to acquire requirements and develop assumptions for the designed IT system
C4 Acquiring teamwork skills

SUBJECT EDUCATIONAL EFFECTS

In terms of knowledge:
PEU_W01 Knows the methods of developing requirements documentation for IT systems
PEU_W02 Knows the principles of developing and managing IT projects

In terms of skills:
PEU_U01 Is able to assess the type and complexity of an IT project and develop

documentation necessary for its implementation

In the field of social competences:
PEU_K01 Is able to cooperate with a team during project implementation

PROGRAMME CONTENT		
Lecture		**Number of hours**
W1	Introduction	2
W2	Project management processes according to PMI	2
W3,4	Preparation of requirements specifications	4
W5,6	Project planning in MS Project	4
W7	Dimensioning of IT projects	2
W8	Team management	2
W9	Cost planning	2
W10	Risk and change management	2
W11,12	Quality management	4
W13	Project monitoring	2
W14	Agile project management methodologies	2
W15	Analysis of sample design documentation	2
	Sum of hours	**30**
Laboratory		**Number of hours**
P1	Introduction and discussion of the requirements and organization of work in the laboratory	1
P2	General characteristics of the MSProject application - familiarization with the interface	2
P3	Project initiation - creating a new ICT project plan	2
P4	Defining the project - planning and creating a task list	2
P5,6	Configuring project resources and assigning them to tasks	4
P7	Format and share your project plan and track progress with basic techniques	2
P8	Presentation of proposed project implementations and passing the course	2
	Sum of hours	**15**
Seminar		**Number of hours**
Semin 1-10	Presentations of selected additional issues related to project management (especially IT)	15
	Total hours	15

TEACHING TOOLS USED
N1 Informative lecture N2 Problem-based lecture N3 Consultations N4 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	Oral exam

	PEU_W02	
F2	PEU_U01,PEU_K01	Project evaluation

P = 0,5*F1+0,4F2
All formative components (F1-F2) must be positive to obtain a positive summary grade P

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Bainey K. Integrated IT Project Management, Artech House, Boston, 2003
[2] A Guide to the Project Management Body of Knowledge, 4th Edition, PMI, 2009.
[3] Jackowski K. Burduk R, System analysis and computer project management, Wrocław University of Technology Advanced Informatics and Control, 2011

SECONDARY LITERATURE:

[1] Alexander I., Beus-Dukic L., Discovering Requirements, John Wiley, 2009

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

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Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

SUBJECT CARD

Name of subject in Polish	**Matematyka dyskretna**
Name of subject in English	**Discrete Mathematics**
Main field of study (if applicable)	**Computer Engineering**
Specialization (if applicable)	**-**
Profile:	**academic**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code	**W04ITE-SM4013**
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			65	
Form of crediting (Examination / crediting with grade)	Examination			Crediting with grade*	
For group of courses mark (X) final course	X				
Number of ECTS points	**5**				
including number of ECTS points for practical classes (P)	-			2,5	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,52			1,52	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1. To acquire advanced knowledge in the scope of mathematical tools used in computer science and engineering
C2. To acquire advanced knowledge in the scope of typical problems formulated in computer science and engineering and suitable solution methods
C3. Improvement of skillfulness in the scope of design, implementation, and evaluation of computer algorithms
C4. To acquire advanced knowledge in the scope of discrete optimization problems and algorithms
C5. To acquire advanced knowledge in the scope of using theoretical tools for the evaluation of efficiency of data structures, code generation, testing, data processing, optimization
C6. To acquire skillfulness in the scope of seeking and using international science literature

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 - knows theoretical tools necessary to design, implement and testing advanced computer algorithms

PEU_W02 - knows typical problems and solution algorithms occurring in computer science and engineering

PEU_W03 - knows selected methods and algorithms in the context of solving discrete optimization problems in computer science and engineering

relating to skills:
PEU_U01 - is able to apply theoretical tools to analyze properties of various computer algorithms
PEU_U02 - is able to design, implement and test advanced algorithm
PEU_U03 - is able to use available software packages to solve optimization problem in computer science and engineering

PROGRAMME CONTENT

Lecture		Number of hours
Lec 1	Discrete problems in computer engineering	2
Lec 2	Computational complexity	2
Lec 3	Combinatory	2
Lec 4	Numbers theory	2
Lec 5	Residual arithmetic	2
Lec 6	Cryptography	2
Lec 7	Graphs and graph algorithms	2
Lec 8	Competitive analysis	2
Lec 9	Differential calculus and discrete convolution	2
Lec 10	Recursive equations, generating functions	2
Lec 11	Linear programing	2
Lec 12	Polynomials and matrices	2
Lec 13	Hardware realization of discrete problems	2
Lec 14	Selected topics of discrete optimization	4
	Total hours	30

Project		Number of hours
Pr1	Organizational matters, occupational health and safety training. Getting to know the software and hardware used in classes.	2
Pr2	Design, implementation and testing of selected graph algorithms - searching for the shortest paths from one vertex to all	2
Pr3	Design, implementation and testing of selected graph algorithms - searching for the shortest paths between all pairs of vertices	2
Pr4	Algorithms for determining the maximum flow in the network Design, implementation and testing of selected online algorithms.	2
Pr5	Using optimization packages - Solver	2
Pr6	Using optimization packages5) – ILOG CPLEX	2
Pr7	Using optimization packages – Gurobi	2
Pr8	Design and implementation of classic, symmetric cryptographic algorithms	2
Pr9	Design and implementation of asymmetric cryptographic algorithms (RSA)	2

Pr10	Design and implementation of asymmetric cryptographic algorithms - continued (El Gamal)	2
Pr11	Implementation of algorithms for solving linear programming problems (Simplex)	2
Pr12	Implementation of algorithms for solving linear programming problems (Karmarkar Algorithm)	4
Pr13	Solving the task, designing and implementing an algorithm for selected problems in the area of discrete optimization (TSP, QAP, VRP)	4
	Total hours	**30**

Seminar		**Number of hours**
Semin 1		
Semin 2		
Semin 3		
…		
	Total hours	

TEACHING TOOLS USED

N1. Lecture with the use of computer slides and blackboard
N2. Project
N3. Consultations
N4. Own students' work – solving project problem
N5. Own students' work – writing project documentation
N6. Own students' work – studying and preparing to exam

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	PEK_U01 – PEK_U03	Reports on partial tasks, project documentation
F2	PEK_W01 – PEK_W03	Written exam
P = 0.5 * F1 + 0.5 * F2, F1>2, F2>2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Cormen T. H., Leiserson C. E., Rivest R. L: Introduction to algorithms, MIT
[2] Rosen K. H.: Discrete Mathematics and Its Applications, McGraw Hill

SECONDARY LITERATURE:

[1] Lipski W.: Kombinatoryka dla programistów, WNT
[2] Albers S.: On-line algorithms, BU

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Załącznik nr 6 do ZW 77/2023

Załącznik nr 4 do programu studiów

FACULTY Information and Communication Technology

SUBJECT CARD

Name of subject in Polish **Metody optymalizacji: teoria i zastosowania**
Name of subject in English **Optimization Methods: Theory and Applications**
Main field of study (if applicable): Computer Engineering
Specialization (if applicable): **-**
Profile: **academic**
Level and form of studies: **2nd level, full-time**
Kind of subject: **obligatory**
Subject code **W04ITE-SM4017G**
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			65	
Form of crediting	Examination			crediting with grade	
For group of courses mark (X) final course	X				
Number of ECTS points	5				
including number of ECTS points for practical classes (P)				2,5	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,36			1,36	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1. To gain knowledge and skills regarding optimization of linear, nonlinear and integer linear programming tasks
C2. To gain knowledge and skills regarding population-based metaheuristic
C3. To gain knowledge and skills regarding practical application of optimization methods

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 – student has an extended/advanced knowledge regarding creation of mathematical models for optimization tasks
PEU_W02 – student has an extended/advanced knowledge regarding optimization of linear programming tasks
PEU_W03 – student has an extended/advanced knowledge regarding optimization of nonlinear programming tasks

PEU_W04 – student has basic knowledge regarding population-based metaheuristic algorithms and their application in optimization problems

relating to skills:
PEU_U01 – student can create mathematical optimization model of real-life problem
PEU_U02 – student can select optimization method for a given optimization problem
PEU_U03 – student can prepare programming simulation software for a given optimization problem

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Optimization methods – practical aspects, examples	2
Lec 2	Linear programming – SIMPLEX	2
Lec 3	Nonlinear programming – non-gradient methods	2
Lec 4	Nonlinear programming – gradient methods	2
Lec 5	Nonlinear programming – Lagrange multipliers	2
Lec 6	Nonlinear programming – Kuhn-Tucker method	2
Lec 7	Integer linear programming – branch and bound, branch and cut, dynamic programming	2
Lec 8	Optimization in continuous spaces – basics and evolutionary strategies	2
Lec 9	Genetic algorithms - introduction and Schema Theory	2
Lec 10	Decomposition of problems	2
Lec 11	The use of decomposition in evolutionary methods	2
Lec 12	Multi-criteria optimization and multi-criteria optimization with a large number of criteria	2
Lec 13	Metaheuristics - the most important types of optimizers	2
Lec 14	Optimization in scheduling problems and the use of evolutionary methods	2
Lec 15	Differential evolution	2
	Total hours	**30**

Project		**Number of hours**
Proj 1	Introduction, discussion of project topics, choosing a problem to optimize.	2
Proj 2	Determining the basic features of the problem (method of coding solutions, possibility of accelerating optimization mechanisms)	4
Proj 3	Simple optimization methods (greedy algorithm, random search)	6
Proj 4	Advanced optimization methods (selectable: linear/non-linear programming, evolutionary methods, other optimizers, including Black-/Gray/White-box selection)	12
Proj 5	Implementation of original ideas to improve the quality and efficiency of optimization	6
	Total hours	**30**

TEACHING TOOLS USED
N1. Lecture N2. Multimedia presentation N3. Consultation N4. Simulation investigations of algorithms N5. Report with the analysis of research results N6. Presentation of the project

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 – W04	Positive final note of written test, activity during lectures
F2	PEU_U01 – U03	Assessment of the project completeness, positive final note of written report describing realized tasks: - Grade in the range of 2.0-4.0 - the implementation of Proj1-Proj4. - Grade 4.5 or higher - high-quality implementation of Proj5 is necessary. - 5.5 - only if the developed project has publication potential.
P = 0.7 F1 + 0.3 F2, +0.5 if the project has publication potential Concluding grade may be passing subject to all F1 – F2 are passing		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Venkataraman P., *Applied optimization with MATLAB programming,* J.Wiley, 2009
[2] Kirk D. , *Optimal Control Theory: An Introduction*, Dover Publications, 2004
[3] Fletcher R., *Practical Methods of Optimization*, J.Wiley, 2000
[4] Bhati A., „Practical Optimization Methods", Springer, 2000
[5] Findeisen W., Szymanowski J., Wierzbicki A., „Teoria i metody obliczeniowe optymalizacji",PWN, Warszawa, 1980
[6] Nocedal J., Wright S.,J., "Numerical Optimization",Springer 1999
[7] Talbi E., *Metaheuristics: From Design to Implementation*, J. Wiley, 2009

SECONDARY LITERATURE:

[1] Athans M. Falb P., *Optimal Control: An Introduction to the Theory and its Applications*, Dover Publications, 2006
[2] Stachurski A., Wierzbicki A.,P., "Podstawy optymalizacji". Oficyna Wydawnicza Politechniki Warszawskiej,Warszawa, 2000
[3] Stachurski M., "Metody numeryczne w programie MATLAB", MIKOM, Warszawa,2003

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Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

SUBJECT CARD

Name of subject in Polish	**Zastosowania informatyki w gospodarce**
Name of subject in English	**IT Applications in Business and Commerce**
Main field of study (if applicable)	**Computer Engineering**
Specialization (if applicable)	**-**
Profile:	**academic**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code	**W04ITE-SM4018G**
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			65	
Form of crediting (Examination / crediting with grade)	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 classes (P)	-			2,5	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,36			1,52	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

C1 Acquisition of knowledge on the application of modern information technologies in commerce and government structures, particularly the varied aspects of economic, regulatory and social requirements

C2 Acquisition of skills in preparing of a proposal and of a computer-based solution for a particular commercial or social application

C3 Acquiring and perfecting the skills in understanding the mechanisms occurring in the modern society, in the context of the profits and dangers of computerization

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 knows the problems of e-business

PEK_W02 knows the web-based technologies used in electronic commerce

PEK_W03 knows the principles of operation of large information processing systems operating in the public sector and in supporting the commerce

PEK_W04 knows the basic regulations of information security and the cryptographic tools required to ensure security

relating to skills:

PEK_U01	is able to make the specification of a complex information system
PEK_U02	can design the software for a commercial project, encompassing the security requirements
PEK_U03	can implement an application for a commercial undertaking that makes use of the up-to-date web technologies and assess its security

relating to social competences:

PEK_K01	is aware of the importance of the influence of modern technologies on the economic and social processes, and can critically analyze the related phenomena
PEK_K02	can cooperate in a programming team, developing a complex information system, fulfilling various functions
PEK_K03	can develop the schedule of programming tasks, assess their priorities and workloads, manage the risks of the project
PEK_K04	understands the security risks connected with the application of IT

PROGRAMME CONTENT

Lecture		Number of hours
Lec 1	Introduction, e-business and e-business applications	2
Lec 2	Web services and microservices architecture	2
Lec 3	Implementation of Web services	2
Lec 4	Virtualization and cloud computing	2
Lec 5	Containerization and container orchestration	2
Lec 6	Rules and mechanisms ensuring information security	2
Lec 7	Secure communication – HTTPS	2
Lec 8	Security of banking transactions	2
Lec 9	Protocols improving the security of CNPT transactions (3D Secure, mobile authorization systems)	2
Lec 10	Blockchain technology and cryptocurrencies – part I	2
Lec 11	Blockchain technology and cryptocurrencies – part II	2
Lec 12	Introduction to IT best industry practices	2
Lec 13	Processes and functions of ITIL	2
Lec 14	Service Management based on ITIL	2
Lec 15	Repetition and final test	2
	Total hours	30

Project		Number of hours
Proj 1	Project topics and requirements	2
Proj 2	Management of a software project, schedule for completing the tasks and methods of risk management	2
Proj 3	Complex information system specification	2
Proj 4	Designing of a web based application for a specific commercial project	6
Proj 5	Implementation and test validation of the software	16

Proj 6	Presentation of the completed application	2
	Total hours	30

TEACHING TOOLS USED

N1. Traditional lecture using video projector
N2. Consultations
N3. Individual work – literature based research
N4. Team work – software development
N5. Preparing the written documentation of the project
N6. Preparing the multimedia presentation of the developed software solution
N7. E-course Introduction to BPM, developed in the framework of POKL, cofunded by EFS and the Polish budget (project „Cloud Computing – new technologies in the educational proposal of Wroclaw University of Technology").

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	PEK_W01÷PEK_W04 PEK_K01, PEK_K04	Written test of choice
F2	PEK_U01÷PEK_U03 PEK_K02, PEK_K03	Analysis of the design solution, written documentation, presentations of the concept and final results
P = 0,4*F1 + 0,6*F2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] S. Surovich, M. Boorshtein. Kubernetes and Docker - an Enterprise Guide. Packt Publishing
[2] Thomas Erl „SOA Design Patterns"
[3] Januszewski A.: Funkcjonalność informatycznych systemów zarządzania, PWN, Warszawa,
[4] Michael Stanleigh: The ISO 10006 and PMBOK Path to Successful Projects
[5] Madras Management Training W.L.L PMP Exam Preparation Course, www.mmt-institute.com
[6] Arraj, Valerie. "ITIL®: the basics." Buckinghampshire, UK (2010).
[7] Gupta, Sourav Sen. "Blockchain." IBM Online (http://www. IBM. COM) (2017).
[8] Bezpieczeństwo aplikacji internetowych dla programistów: rzeczywiste zagrożenia, praktyczna ochrona, McDonald, Malcolm. Autor (2021)
[9] Cybersecurity fundamentals: a real-world perspective / Kutub Thakur, Al-Sakib Khan Pathan. Thakur, Kutub. (2020)

SECONDARY LITERATURE:

[1] Matjaz B. Juric , Kapil Pant "Business Process Driven SOA using BPMN and BPEL"
[2] Markus Aleksy "Implementing Distributed Systems with Java & CORBA"
[3] Dave Chaffey "E-Business and E-Commerce Management: Strategy, Implementation and Practice "
[4] Agutter, Claire. ITIL Foundation Essentials ITIL 4 Edition-The Ultimate Revision Guide. IT Governance Publishing Ltd, 2020Wendy Shih, ITIL: Why Your IT Organization Should Care Service Support, Kent State University
[5] The Official ITIL Site, online http://www.itil.org
[6] ITIL Community Forum, online http://www.itilcommunity.com

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Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

SUBJECT CARD

Name of subject in Polish: **Modelowanie systemów informatycznych**
Name of subject in English: **Information Systems Modeling**
Main field of study (if applicable): **Informatyka Techniczna**
Specialization (if applicable):
Profile: **academic**
Level and form of studies: **2nd level, full-time**
Kind of subject: **obligatory**
Subject code: **W04ITE-SM4019G**
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		30		
Form of crediting (Examination / 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)	-		1,5		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,36		0,68		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Programming in Java

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SUBJECT OBJECTIVES

C1 To acquire knowledge and skills related to the use of design patterns in the analysis, design and programming of multi-tier information systems
C2 To acquire knowledge and skills related to the design and implementation of web services
C3 To acquire knowledge and skills related to the definition and use of classical and semantic data models

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Knows the iterative and development process of building IT systems with multi-layer architecture, including issues related to requirements analysis and building models using UML, SysML, BPMN.
PEU_W02 Knows the use of popular design patterns and the principles of creating SOAP and REST web services on the JAVA platform
PEU_W03 Knows the basics of describing Internet resources using RDF and OWL
PEU_W04 Knows the methods of formal description of network service interfaces using WSDL and OpenAPI

relating to skills:

PEU_U01 Is able to design and implement a simple IT system with a multi-layer architecture using REST and SOAP network services on the JAVA platform
PEU_U02 Is able to recognize the context of occurrence and use of appropriate design patterns

PEU_U03 Is able to create and use semantic descriptions of web resources expressed in RDF and OWL
PEU_U04 Is able to describe web service interfaces in WSDL and OpenAPI

relating to social competences:
PEK_K01 He can assess his own role in the team working on information systems design in a view of requirements specification, model building and implementation

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	An overview of course content. The process of designing multi-layer IT systems, formalisms used, the role and place of design patterns.	2
Lec 2	Methods for specifying requirements and documenting implementation (using SysML, UML diagrams and user interface mockups).	2
Lec 3	Design and implementation of network service interfaces (design patterns and standards used, including OpenAPI).	2
Lec 4	Basics of creating web applications using the Spring and SpringBoot frameworks of the Java platform.	2
Lec 5	Basics of GUI implementation for web services (building a front-end using Angular and AngularJS).	2
Lec 6	Construction of the persistence layer and its integration with the presentation layer (displaying and consuming data through the end-points).	2
Lec 7	The role and use of aspect-oriented programming (AOP, AspecjJ).	2
Lec 8	Business processes' modeling and implementation (involving the use of BPMN language).	2
Lec 9	XML in the implementation of web services (XML, XML Schema, WSDL, SOAP, code-first and contract-first approaches).	2
Lec 10	Introduction to semantic web technologies: RDF, RDFS.	2
Lec 11	Introduction to semantic web technologies: OWL/OWL2.	2
Lec 12	Graph databases and the SPARQL query language.	2
Lec 13	Semantic Internet, the idea of LOD linked data.	2
Lec 14	Graph validation using SHACL (Shapes Constraint Language).	2
Lec 15	Repetition, final colloquium.	2
	Total hours	30

	Laboratory	**Number of hours**
Lab 1	Specification of requirements for a website using selected formalisms (SysML, UML languages).	2
Lab 2	Modeling related processes using BPMN.	2
Lab 3	Design and implementation of REST web services ensuring the implementation of functions specified in the requirements.	2

Lab 4	Implementation of the persistence layer and the presentation layer. Integration of implemented layers (consuming data provided via the REST interface)	2
Lab 5	Extending the website's functions by reporting selected activities using aspects.	2
Lab 6	Designing custom ontology in RDF and building knowledge base with the of this ontology, loading the knowledge base into a graph database, designing queries to the knowledge base.	2
Lab 7	Using RDFa and JSON-LD to publish metadata on the websites.	2
Lab 8	Summary of classes.	1
	Total hours	15

TEACHING TOOLS USED
N1. Traditional lectures using video projector N2. Laboratory exercises N3. Consultations N4. Own work - preparation for laboratory exercises N5. Own work - self-study and exam preparation

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	PEK_U01÷PEK_U04 PEK_K01	Evaluation of the laboratory assignments outcomes (taking into account the quality of the generated code and the scope of functions implemented), assessment of the level of skills (based on the answers to questions on the tasks completed)
F2	PEK_W01÷PEK_W04 PEK_U01÷PEK_U04	Written test (The necessary condition is to obtain a positive F1)
P = 0.6*F1+0.4*F2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] J. Rumbaugh, I. Jacobson, G. Booch, *The Unified Modeling Language Reference Manual.* Addison Wesley, 2005

[2] E. Gamma, R. Helm, R. Johnson, and J. Vlissides. *Design Patterns: Elements of Reusable Object-Oriented Software*. Addison-Wesley Professional Computing Series. Addison-Wesley Publishing Company, New York, NY, 1995

[3] S. Weerawarana, F. Curbera, F. Leymann, T. Storey. *Web Services Platform Architecture: SOAP, WSDL, WS-Policy, WS-Addressing, WS-BPEL, WS-Reliable Messaging, and More.* Prentice Hall 2005

[4] J. Hebeler, M. Fisher, R. Blace, A. Perez-Lopez, *Semantic Web Programming*, Wiley Publishing, Inc. 2009

[5] M. Yener, A. Theedom, *PROFESSIONAL Java® EE Design Patterns*, John Wiley & Sons, 2015

[6] C. Walls, R. Breidenbach, *Spring in Action*, Manning Publications, 2005
[7] R. Laddad, *AspectJ in Action. Practical aspect-oriented programming*. Manning Publications, 2003
[8] V. Karpov, D. Netto, *PROFESSIONAL AngularJS*, John Wiley & Sons, 2015
[9] R. Crowther, J. Lennon, A. Blue, G. Wanish, HTML5 in Action, Manning Publications, 2014

SECONDARY LITERATURE:

[10] A. Deepak, J. Crupi, D. Malks, Core J2EE Patterns: Best Practicies and Design Strategies, 2nd Edition
[11] Design Patterns in Java Tutorial, https://www.tutorialspoint.com/design_pattern/
[12] RDF 1.1 Primer, W3C Working Group Note 24 June 2014, https://www.w3.org/TR/rdf11-primer/
[13] RDFa 1.1 Primer - Third Edition, Rich Structured Data Markup for Web Documents, W3C Working Group Note 17 March 2015, https://www.w3.org/TR/rdfa-primer/
[14] Java Design Patterns At a Glance, http://www.javacamp.org/designPattern/index.html
@AspectJ Based AOP with Spring, https://www.tutorialspoint.com/spring/aspectj_based_aop_appoach.htm

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Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY **Information and Communication Technology**

SUBJECT CARD

Name of subject in Polish **Badania naukowe, metody, zasady, realizacja**
Name of subject in English **Research Skills and Methodologies**
Main field of study (if applicable): Computer Engineering
Specialization (if applicable): -
Profile: **academic**
Level and form of studies: **2nd level, full-time**
Kind of subject: **obligatory**
Subject code **W04ITE-SM4020G**
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)	25				50
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)					2
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,68				1,36

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1 Acquiring knowledge in the field of new trends related to the subject of scientific research, algorithms and solving complex research problems.
C2. Acquiring the ability to prepare a multimedia computer presentation and to present it at the seminar

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 has knowledge of the methods and principles of algorithm design for the purpose of solving optimization problems
PEU_W02 has knowledge of the architecture of computer simulation systems for the needs of experimental research
PEU_W03 has knowledge of the planning of experiments and the analysis of their results
PEU_W04 has knowledge of new trends related to the subject of scientific research, algorithms and solving complex research problems

relating to skills:
PEU_U01 is able to independently choose a subject in accordance with the requirements set and explore it through literary studies
PEU_U02 is able to prepare a multimedia computer presentation on a given topic and present it on the forum

relating to social competences:
PEU_K01 can use literature sources and select materials available on the Internet

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Organizational matters, rules of passing	**2**
Lec 2	Principles of conducting simulation research. Computer simulation. Formulating research theses. Planning of multi-stage experiments. Comparative research on the effectiveness of algorithms - quality indicators. Multifaceted simulation research	**2**
Lec 3	Analysis of the results of simulation experiments. Presentation of research results - the principles of creating reports and processing the results in the form of scientific articles.	**2**
Lec 4	Presentation of new trends related to the subject of scientific research, algorithms and solving complex research problems	**9**
	Total hours	**15**

Seminar		**Number of hours**
Semin 1	Organizational matters	**2**
Semin 2	Reporting the subject of the presentation, arrangements with the supervisor	**4**
Semin 3	Student presentations related to the selected topic	**20**
Semin 4	Discussion of the presented presentations, tips, evaluation	**4**
	Total hours	**30**

TEACHING TOOLS USED

N1. Multimedia presentation
N2. Problem discussion
N3. Consultations
N4. 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	Activity on the subject, test
F2	PEU_U01,PEU_U02, PEU_K01	Evaluation of the multimedia presentation - content and presentation
P = 0,4 * F1 + 0,6 * F2, with condition: [(F1 ≥ 3.0) ∧ (F2 ≥ 3.0)]		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Cormen Thomas H., Leiserson Charles E., Rivest Ronald L, Clifford Stein "Wprowadzenie do algorytmów" Wydawnictwo Naukowe PWN 2020

[2] Omid Bozorg-Haddad, Mohammad Solgi, Hugo A. Loáiciga "Meta-heuristic and Evolutionary Algorithms for Engineering Optimization", Wiley 2017

[3] D.C. Montgomery, „Design and Analysis of Experiments", 2012

[4] popular science webpages

SECONDARY LITERATURE:

Scientific papers - IEEE Xplore, Google Scholar etc.

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

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Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF Information and Communication Technology

SUBJECT CARD

Name of subject in Polish: **Bezpieczeństwo systemów i sieci komputerowych**
Name of subject in English: **Secure Systems and Networks**
Main field of study (if applicable): **Computer Science**
Specialization (if applicable): **-**
Profile: **academic**
Level and form of studies: **2nd level, full-time**
Kind of subject: **obligatory**
Subject code: **W04ITE-SM4021G**
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)	50		25		
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)	-		1		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,36		0,68		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge on computer networks.
2. Basic knowledge on computer operating systems.

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SUBJECT OBJECTIVES

C1 Learning current problems regarding security of computer systems and networks
C2 Learning analysis skills for security-related problems
C3 Learning how to apply security solutions

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 – student knows software and hardware authentication and authorization methods
PEK_W02 – student is acquaintanted with One Time Passwords, tokens, access cards
PEK_W03 – student knows methods for securing transmissions in computer networks
PEK_W04 – student knows basics of cryptography, can distinguish public and private key cryptosystems
PEK_W05 – student knows what is the data integrity, understands synchronization problems in distributed systems
PEK_W06 – student knows problems related to malware programs
PEK_W07 – student knows basic methods of writing secure programs

PEK_W08 – student knows typical programming problems causing security problems, such as buffer overflow, and knows how these problems can be avoided
PEK_W09 – student is aware of sniffing and spoofing techniques in TCP/IP networks
PEK_W10 – student knows masquerading techniques and how firewall systems work
PEK_W11 – student knows and can distinguish security problems in layers 2-4 of the OSI model for TCP/IP networks (ping of death, smurf and other types of attacks)
PEK_W12 – student is aware of problems related to particular network services, such as NFS, FTP, RLOGIN, DNS, SMTP, SSH, FTP. HTTP.
PEK_W13 – student knows physical security methods for data protection (backups, disk storage arrays)

relating to skills:

PEK_U01 – student can assess security level of different authentication methods
PEK_U02 – student can show various alternative methods for increasing security of system access
PEK_U03 – student can show typical errors in network server configurations
PEK_U04 – student can recognize typical network attacks such as smurf, ping of death, land and similar.
PEK_U05 – student can perform network scan
PEK_U06 – student can use sniffing techniques and network analysers
PEK_U07 – student can check data integrity and use cryptographic techniques (including SSL) to improve system security
PEK_U08 – student can configure firewall system
PEK_U09 – student can find and use information about current security problems and trends in computer and systems security

relating to social competences:

PEK_K01 – student is aware of the importance of defensive programming
PEK_K02 – student is aware of responsibility related to the knowledge of security problems in programs and computer systems
PEK_K03 – student understands importance of self-study and applying the knowledge by practicing it in real systems

PROGRAMME CONTENT

Form of classes - lecture		**Number of hours**
Lec 1	File system access, programs with special privilleges,	2
Lec 2	Memory access, Authentication and authorization methods, traditional	2

	and one-time passwords	
Lec 3	System configuration errors, sniffing and spoofing	2
Lec 4	Basics of cryptography	2
Lec 5	Cryptographic protocols	2
Lec 6	Security of computer networks in OSI layers 1-3 (TCP/IP)	2
Lec 7	Security of network protocols – remote login. FTP, NFS, DNS,	2
Lec 8	Security of network protocols – SMTP, HTTP, other	2
Lec 9	Packet filtering and firewall systems	2
Lec 10	Secure Sockets Layer (SSL)	2
Lec 11	Malware: viruses, trojans, worms, etc.	2
Lec 12	Security holes, systems configuration	2
Lec 13	Safe programming. (shell scripts, system calls in applications)	2
Lec 14	IDS systems, secure protocols, data integrity	2
Lec 15	Final test.	2
	Total hours	30

Form of classes - laboratory		**Number of hours**
La1	Network sniffing	2
La2	portscanning and pentesting	4
La3	SSL certificates and server configuration	3
La4	SSL programming	3
La5	Firewalls	3
	Total hours	**15**

TEACHING TOOLS USED
N1. Traditional lecture with multimedia presentation. N2. Consultations. N3. Self-study – preparation for the final test.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learnign outcomes code	Way of evaluating learning outcomes achievement
F1	PEK_U01-PEK_U09 PEK_K01-PEK_K03	Laboratory assessment
F2	PEK_W01-PEK_W13	Final test
P=0.7*F1+0.3*F2, positive result of lab and seminar assessment is required for passing		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Tomasz Surmacz – Secure Systems and Networks
[2] Garfinkel & Spafford, Practical Unix and Internet Security, 2nd Edition
[3] B. Schneier, Practical Cryptography

SECONDARY LITERATURE:

[1] A. Silberschatz, Operating System Concept, 7th Edition
[2] M. Bach, The Design of the UNIX Operating System
[3] R. Stevens, UNIX Network Programming

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

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Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF **Information and Communication Technology**

SUBJECT CARD

Name of subject in Polish: **Seminarium dyplomowe**
Name of subject in English: **Internet Engineering Seminar**
Main field of study: **Computer Engineering**
Specialization: **Internet Engineering**
Profile: **academic**
Level and form of studies: **2nd level, full-time**
Kind of subject: **optional**
Subject code: **W04ITE-SM4114**
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)					75
Form of crediting					crediting with grade
For group of courses mark (X) final course					
Number of ECTS points					**3**
including number of ECTS points for practical classes (P)					3
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)					1,36

SUBJECT OBJECTIVES

C1 Acquisition of skills in selective search of knowledge needed to develop one's own original solutions.
C2 Acquisition of skills in preparing a presentation that clearly communicates one's concepts and solutions.
C3 Acquiring the skills of discussion, presenting one's motivation and defending the point of view.
C4 Acquiring the skills in writing a publication presenting one's achievements in the perspective of the current international research.

SUBJECT EDUCATIONAL EFFECTS

relating to skills:

PEK_U01	can apply the rules how to write a publication on the personal research results and achievements
PEK_U02	is able to make a presentation with the personal research results
PEK_U03	can defend during discussion the motivation and the results of proposed solutions
PEK_U04	can critically assess the presentations of other people

PROGRAMME CONTENT

Form of classes - seminar		Number of hours
Sem 1	The principles of developing and writing the Mastr Thesis, particularly the editorial requirements	2
Sem 2	The principles of preparing a scientific multimedia presentation, its structure, content and graphical formatting	2
Sem 3	Individual presentations of the students, concerning the state of the art related to the thesis topic and the aims and concepts related to the state of the art	8
Sem 4	Discussion by the group concerning the state of the art and the proposed solutions	6
Sem 5	Individual presentations of the students, concerning the results achieved in final project, and particularly the original achievements	12
	Total hours	30

TEACHING TOOLS USED

N1. Multimedia presentation
N2. Problem oriented discussion
N3. 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	PEK_W01÷PEK_W02 PEK_U01÷PEK_U02	Presentation
F2	PEK_U03	Discussion
P = 0,6*F1 + 0,4*F2; F1>2, F2>2		

PRIMARY AND SECONDARY LITERATURE

Literature connected with the topic of the Master Thesis

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

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Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

SUBJECT CARD

Name of subject in Polish	Multimedia i wizualizacja komputerowa
Name of subject in English	Multimedia and Computer Visualisation
Main field of study (if applicable)	**Computer Engineering**
Specialization (if applicable)	**Internet Engineering**
Profile:	**academic**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code	**W04ITE-SM4115**
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)	45			80	
Form of crediting (Examination / crediting with grade)	Exam			crediting with grade	
For group of courses mark (X) final course	X				
Number of ECTS points	**5**				
including number of ECTS points for practical classes (P)	-			3	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,84			1,52	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Ability to understand the basics of computer graphics and the representation of images in computer memory.
2. Ability to understand symbolic notation to describe basic phenomena in image processing.
3. Ability to think abstractly to understand physical phenomena and their representation in image processing.

SUBJECT OBJECTIVES

C1. Learn the methods of acquisition, processing, compression and transmission of static images and film sequences.
C2. Acquire skills in software processing and compression of digital images.

C3. Learn to use a digital image editing and processing package.
C4. Acquire skills in the creation of digital films showing movement in 3D scenes.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 - knows methods of acquisition and basic algorithms for processing and digital images.
PEU_W02 - knows the basics of digital television systems.
PEU_W03 - knows algorithms for processing 2D graphic material and 3D scenes and methods for compressing multimedia data.

relating to skills:
PEU_U01 - can independently write programmes that implement basic digital image processing and compression algorithms.
PEU_U02 - be able to use image editing and processing software.
PEU_U03 - be able to produce a simple multimedia material showing movement in a synthetic 3D scene.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Introduction, organisational matters.	1
Lec 2	Basics of colour theory. Numerical models describing colour used in computer graphics and multimedia technologies.	2
Lec 3	Digital images, image acquisition, mathematical models and numerical properties of images.	2
Lec 4	Basics of television.	2
Lec 5	Digital television. DVB standard.	2
Lec 6	Compression of static images. JPEG algorithm.	2
Lec 7	Compression of moving pictures. MPEG-2 algorithm.	2
Lec 8	Compression of audiovisual scenes. H.264 / H.265 algorithm.	2
	Total hours	**15**

Project		**Number of hours**
Proj 1	Introduction, organisational matters. Discussion and assignment of project tasks.	2
Proj 2	Develop, review and approve project assumptions. Preparation of a document specifying the accepted assumptions.	4
Proj 3	Develop software to implement the project task. Test the software. Preparation of examples illustrating the operation of the implemented programme.	12
Proj 4	Preparation of a written report documenting the work carried out.	8
Proj 5	Prepare and give a presentation summarising the project.	4
	Total hours	**30**

TEACHING TOOLS USED

N1. Traditional lecture with video projector
N2. Project tasks (programming)
N3. Consultation

N4. Own work - preparation for laboratory classes N5. Own work - preparation of software and documentation within the project

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	exam test
F2	PEU_U01÷PEU_U03	program implementing the project task, written documentation of the project
P = 0,51*F1 + 0,49*F2; F1 > 2, F2 > 2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Angel E., Interactive Computer Graphics A Top-Down Approach Using OpenGL, Addison Weslay, 2006.
[2] Awcock, Graeme J., and Ray Thomas. Applied image processing. Basingstoke, UK: Macmillan, 1995.
[3] Domański, Zaawansowane techniki kompresji obrazów i sekwencji wizyjnych, PPPP Poznań 2000.
[4] Drozdek A. Wprowadzenie do kompresji danych, WNT Warszawa 1999
[5] Grafika komputerowa metody i narzędzia, pod red. J. Zabrodzkiego, WNT, 1994.
[6] Gonzales R., Woods R., Digital Image Processing, Prentice-Hall, New Jersey, 2002.
[7] Marion, André. Introduction to image processing. Springer, 2013.Pavlidis T., Grafika i przetwarzanie obrazów, WNT, Warszawa, 1987.
[8] Skarbek W., Metody reprezentacji obrazów cyfrowych, PLJ, Warszawa, 1993.
[9] Sonka, Milan, Vaclav Hlavac, and Roger Boyle. Image processing, analysis and machine vision. Springer, 2013.
[10] Russ J. C., The Image Processing Handbook, CRC Press, Wydanie V, 2007,
[11] Yun Q. Shi, Huifang Sun. Image and Video Compression for Multimedia Engineering: Fundamentals, CRC Press, 2008
[12] Woods E., Richard, and Rafael C Gonzalez. "Digital image processing." (2008).

SECONDARY LITERATURE:

[1] Journals available at IEEE Explore (http://ieeexplore.ieee.org)
[2] Web resources related to image engineering

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

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Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

SUBJECT CARD

Name of subject in Polish	**Programowanie w technologii Java i XML**
Name of subject in English	**Application Programming - Java and XML Technologies**
Main field of study (if applicable)	**Computer Engineering**
Specialization (if applicable)	**Internet Engineering**
Profile:	**academic**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code	**W04ITE-SM4116**
Group of courses	**YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	15	15		
Number of hours of total student workload (CNPS)	50	25	50		
Form of crediting (Examination / crediting with grade)	crediting with grade	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 classes (P)		1	1.5		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.36	0.68	0.68		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1 Acquiring basic knowledge, including application aspects in the field of XML document processing
C2 Acquiring knowledge in the field of creating web applications using Java EE technology
C3 Acquiring practical skills in designing and processing XML documents
C4 Acquiring practical skills in creating simple applications using web services
C5 Acquiring the ability to present works (created structures, architectures) in a group forum

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 – knows the structure of XML documents
PEU_W02 – knows XML document validation techniques
PEU_W03 – knows various techniques for processing XML documents
PEU_W04 – knows the principles and techniques of creating Java EE applications

relating to skills:
PEU_U01 – can create and validate XML documents

PEU_U02 – can use the XSLT transform
PEU_U03 – can programmatically process XML documents
PEU_U04 – can use IT tools to create diagrams and languages describing the application being created
PEU_U05 – is able to prepare a presentation that is an element of disseminating knowledge in the group forum

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Fundamentals of XML and DTD	2
Lec 2	XSLT i XPATH	2
Lec 3	XML Schema	2
Lec 4	XML Document Object Model	2
Lec 5	Java API for XML Processing	2
Lec 6	Java Architecture for XML Binding	2
Lec 7	Java EE applications	4
Lec 8	JAX-WS	2
Lec 9	JAX-RS	2
Lec 10	JavaScript and HTML DOM	2
Lec 11	AJAX	2
Lec 12	JSON	2
Lec 13	RIA	2
Lec 14	Test	2
	Total hours	**30**

Classes		**Number of hours**
Cl 1	Organizational matters, introduction, definition of the problem, presentation of the exercise topics	2.5
Cl 2	Discussion of diagrams used in software engineering and their relationship to the XML description language and methodologies for translating these relationships into a Java application	2.5
Cl 3	Introduction, presentation of problems and issues concerning Java and XML technologies based on the given diagrams and scientific articles	2.5
Cl 4	Presentation and discussion of details of a specific project where XML and Java were the basis of the system architecture	2.5
Cl 5	Introduction, presentation of various frameworks related to Java or XML technology to expand the knowledge of possible solutions	2.5
Cl 6	Presentation of the complete architecture, specifics, and ideas of the implementation of a certain system (proposal of frameworks, architecture diagrams, XML or DTD diagrams for XML input-output documents, proposals for algorithms and modular connections)	2.5
	Total hours	15

Laboratory		Number of hours
Lab 1	Occupational health and safety job training. Organizational matters. Familiarization with the programming environment	1
Lab 2	XML documents and DTDs	2
Lab 3	XSLT Transformation	2
Lab 4	Document validation using XML Schema	2
Lab 5	XML document processing in Java - XML DOM	2
Lab 6	XML document processing in Java - SAX and STAX	2
Lab 7	XML document processing in Java - JAXB	2
Lab 8	XML - processing of large documents, study of computational complexity	2
	Total hours	15

TEACHING TOOLS USED

N1. Lectures using slides
N2. Laboratory classes - execution of programs
N3. Group discussion
N4. Consultation
N5. Own work - analysis of solutions, development of presentations

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 – U04	Oral answers, observation of exercise performance, demonstration of application performance
F2	PEU_U05	Oral answers, discussions, presentations
F3	PEU_U05	Development of a presentation on a topic given by the instructor
F4	PEU_W01 – W04	Final test
P=0.35*F1+0.15*F2+0.2*F3+0.3*F4		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] [1] E. R. Harold, *XML Bible*
[2] S. Holzner, *Inside XML*
[3] A. Goncalves, *Beginning Java EE 6 with GlassFish 3*, Apress
[4] K. Michalska, T. Walkowiak *Application programming - Java and XML technologies*
[5] E-portal

SECONDARY LITERATURE:

[1] B. Burke, R. Monson-Haefel, Enterprise JavaBeans 3.0
[2] S. D. Olson, Ajax on Java

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

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Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY **Information and Communication Technology**

SUBJECT CARD

Name of subjec in Polish	**Analiza systemów informatycznych**
Name of subjec in English	**Information Systems Analysis**
Main field of study (if applicable):	**Computer Engineering**
Specialization:	**Internet Engineering**
Profile:	**academic**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code	**W04ITE-SM4117**
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)	50		75		
Form of crediting	exam		crediting with grade		
For group of courses mark (X) final course	X				
Number of ECTS points	5				
including number of ECTS points for practical classes (P)	0		3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,52		1,36		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

K2INF_W01

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SUBJECT OBJECTIVES

C1. The acquisition of knowledge and skills on information systems modelling and analysis with the use of Petri nets without time factor.
C2. The acquisition of knowledge and skills on information systems modelling and analysis with the use of Petri nets with time factor.
C3. The acquisition of knowledge and skills on information systems modelling with the use of finite automata.
C4. Acquiring the knowledge and skills on information systems verification with the use of finite automata and temporal logic.
C5. Acquiring the skills on automatic model verification with the use of finite automata and temporal logic.
C6. The acquisition of knowledge and skills on assessment of execution time of sequential programs.
C7. Acquiring the knowledge and skills on information system performance evaluation using queueing

networks.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 - He/She knows the methods of analysis of Petri nets without time factor.

PEK_W02 - He/She knows the methods of analysis of Petri nets with time factor.

PEK_W03 - He/She knows the syntax and semantics of temporal logics LTL, CTL, RTCTL and TCTL and their formulae.

PEK_W04 - He/She knows the examples of models of simple systems (technical, biological and information) represented by system of finite automata.

PEK_W05 He/She knows the definition of temporal data bases, fundamentals of their construction, and their applications.

PEK_W06 He/She knows the assessment method of execution time of sequential programs.

PEK_W07 He/She knows the structure of queueing network models.

PEK_W08 He/She knows selected methods of calculating the queueing network characteristics.-

relating to skills:

PEK_U01 He/She can use Petri nets without time factor in modelling and analysis of simple systems.

PEK_U02 He/She can use Petri nets with time factor in modelling and analysis of systems.

PEK_U03 He/She can create model of information system as the system of finite automata.

PEK_U04 He/She can define and verify the information system properties expressed in LTL, CTL, RTCTL and TCTL temporal logics formulae.

PEK_U05 He/She can apply UPPAAL program for modelling and verification of system.

PEK_U06 He/She can apply NuSMV program for modelling and verification of system.

PEK_U07 He/She can build the queueing model of real system.

PEK_U8 He/She can build the simulation model of queueing system, execute its simulation, and correctly interpret the results.

PEK_U9 He/She can build the analytic model of queueing system and calculate its performance characteristics.

PROGRAMME CONTENT

Form of classes - lecture		**Number of hours**
Lec 1	Introduction into modelling of concurrent systems using Petri nets	1
Lec 2	Behavioral properties of Petri nets: boundness, safety, reachability, liveness, reversibility, existence of home marking, persistency	4
Lec 3	Synchronization distance, bounded fairness relation	1
Lec 4	Time Petri nets	1,5
Lec 5	Coverability tree	1
Lec 6	Matrices and net reductions in analysis of Petri nets properties	1,5

Lec 7	Introduction into performance evaluation of information systems	1
Lec 8	Performance evaluation of sequential programs	1
Lec 9	Performance evaluation using queueing models	2
Lec 10	Fundamental laws of operational analysis	4
Lec 11	Stochastic and generalized stochastic Petri nets	2
Lec 12	LTL logic	2
Lec 13	CTL logic	1
Lec 14	Model verification of system	1
Lec 15	Model verification of system using UPPAL time state automata	2
Lec 16	Model verification of system using NuSMV state automata	3
Lec 17	Another kinds of temporal logics and temporal data bases	1
	Total hours	30

Form of classes - laboratory		**Number of hours**
Lab 1	OSHA workplace training. Organizational matters. Familiarization with Petri net tools.	1
Lab 2	Introduction into Petri nets by modelling the simple changes in environment, automation system and information processing process for chosen examples.	1
Lab 3	Modelling of real systems from selected fields using Petri nets. Evaluation of selected system properties (safety, liveness, finiteness of process) by Petri net properties analysis.	4
Lab 4	Application of time Petri nets in modelling real systems from selected domains.	4
Lab 5	Acquainting with simulation and analytic queuing model solution tools.	2
Lab 6	Queuing models creation, simulation and analytic research, and interpretation of results for open models without client (task) returns on service stations.	4
Lab 7	Queuing models creation, simulation and analytic research, and interpretation of results for open models with client (task) returns on some service stations.	2
Lab 8	Applying generalized stochastic Petri in modelling real systems from selected domains.	2
Lab 9	Aquatinting with tools UPPAAL and NuSMV for model checking of systems.	2
Lab 10	Information system model as cooperating time automata in UPPAAL. System properties specification in CTL logic, and the verification of these properties using UPPAAL.	4
Lab 11	Information system model as cooperating automata in NuSMV tool. System properties specification in LTL, CTL, RTCTL, and the verification of these properties using NuSMV.	4

	Total hours	30

TEACHING TOOLS USED
N1. Traditional lectures using video projector N2. Laboratory exercises N3. Consultations N4. Own work - preparation for laboratory exercises N5. Own work - self-study and exam preparation

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
F11	PEK_U01 ÷ PEU_U02	Observation of: the preparation to the laboratory exercises and execution of the exercises, the results achieved.
	PEK_W01 ÷ PEK_W02	Verbal or written responses on questions associated with the lectures.
F21	PEK_U03 ÷ PEK_U06	Observation of: the preparation to the laboratory exercises and execution of the exercises, the results achieved.
	PEK_W03 ÷ PEK_W05	Verbal or written responses on questions associated with the lectures.
F31	PEK_U07 ÷ PEK_U9	Observation of: the preparation to the laboratory exercises and execution of the exercises, the results achieved.
	PEK_W06 ÷ PEK_W08	Verbal or written responses on questions associated with the lectures.
F12	PEK_W01 ÷ PEK_W02	Written or verbal exam
F22	PEK_W03 ÷ PEK_W05	Written or verbal exam
F32	PEK_W06 ÷ PEK_W08	Written or verbal exam
P=2 if (F11=2 or F21=2 or F31=2 or F12=2 or F22=2 or F32=2) P=(F1+F2+F3)/3 otherwise, where: F1=F11 if F11≥4,5, F1=F12 otherwise F2=F21 if F21≥4,5, F2=F22 otherwise F3=F31 if F31≥4,5, F3=F32 otherwise		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] T. Murata, Petri nets: Properties, analysis and applications, Proceedings of the IEEE, 1989, Vol. 77, No. 4, 541-580
[2] W. Reisig, Petri Nets – An Introduction, Springer, 1985.
[3] W. Reisig, Sieci Petriego, WNT, 1988.
[4] M. Szpyrka, Sieci Petriego w modelowaniu i analizie systemów współbieżnych, Inżynieria oprogramowania, WNT, 2008.
[5] E.A. Emerson „Temporal and modal logic", 1995
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[7] E.A. Emerson et al. „Parametric Quantitative Temporal Reasoning", 1999
[8] G. Behrmann et al. "A tutorial on UPPAAL", 2004, at: www.uppaal.com
[9] R. Alur et al. "Automata for modelling real-time systems", 1990
[10] R. Cavada et al. „NuSMV 2.5 User Manual", 2010
[11] R. Cavada et al. „NuSMV 2.5 Tutorial"
[12] E. D. Lazowska, J. Zahorjan, G. S. Graham, K. C. Sevcik, Quantitative System Performance, Computer System Analysis Using Queueing Network Models, Prentice-Hall, Englewood Cliffs, 1984.
[13] T. Czachórski, Modele kolejkowe w ocenie efektywności sieci i systemów komputerowych, Wydawnictwo Pracowni Komputerowej Jacka Skalmierskiego, Gliwice, 1999.

SECONDARY LITERATURE:

[1] B. Berthomieu, M. Menasche, *A State Enumeration Approach for Analyzing Time Petri Nets*, 3. European Workshop on Applications and Theory of Petri Nets, Varenna (Italy), September 1982
[2] B. Berthomieu, M. Menasche, *Time Petri Nets for Analyzing and Veryfying Time Dependent Communication Protocols,* 3. IFIP WG 6.1 Workshop on Protocol Specification Testing and Verification, Rueschlikon (Schwizerland), May-June 1983
[3] IEEE 1363: Standard Specification for Public-Key Cryptography
[4] B. Berthomieu and M. Diaz, *Modeling and Verification of Time Dependent Systems Using Time Petri Nets*, IEEE Transaction of Software Engineering, vol. 17, no. 3, march 1991
[5] J. Magott, New NP-complete problems in performance evaluation of concurrent systems using Petri nets, IEEE Transactions on Software Engineering,1987 May, 578 – 581.
[6] Bonet P., Lladó C. M., Puigjaner R., Knottenbelt W., PIPE v. 2.5: a Petri Net Tool for Performance Modeling, Palma de Mallorca, Universitat de les Illes Balears, Spain, 2007; http://www.doc.ic.ac.uk/~wjk/publications/bonet-llado-knottenbelt-puijaner-clei-2007.pdf
[7] Marsan M. A., Stochastic Petri Nets: An Elementary Introduction, Universitá di Milano, Italy;

http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.110.2081&rep=rep1&type=pdf
[8] A. David et al. “UPPAAL 4.0: Small tutorial”, 2009, at: www.uppaal.com
[9] J.E. Hopcroft, J.D. Ullman “Introduction of Automata Theory, Languages, and Computation”, 2001
[10] Goldsim – symulator systemów zdarzeniowych, http://www.goldsim.com.
[11] Rapid Analysis of Queueing Systems (RAQS), http://www.okstate.edu/cocim/raqs/raqs.htm

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

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Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY Information and Communication Technology

SUBJECT CARD

Name of subject in Polish	**Systemy inteligentnego przetwarzania**
Name of subject in English	**Softcomputing**
Main field of study (if applicable):	**Computer Science**
Specialization (if applicable):	**Internet Engineering**
Profile:	**academic**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	**W04ITE-SM4119**
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)	65			60	
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 classes (P)	-			2	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,36			1,52	

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1. Knowledge of artificial neural networks in pattern recognition, digital signals, and data processing: topology of networks, influence of parameters for network behavior.
C2. Knowledge of genetic algorithms used for data pre- and postprocessing.
C3. Knowledge of expert systems – reasoning rules and knowledge base creation for different tasks.
C4. Skills in special environment usage for project phase, modeling, and simulation of softcomputing systems in case of different scientific problems.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 – knows the rules and the idea of intelligent processing.
PEK_W02 – defines the fuzzy sets and understands the idea of approximate reasoning.
PEK_W03 – defines the knowledge base and reasoning rules, knows the expert systems construction.
PEK_W04 – knows the architecture of typical artificial neural networks structures, learning and retrieving algorithms, applications.
PEK_W05 – knows the description, classification, examples of applications of genetic algorithms

relating to skills:

PEK_U01 – can use the environments for project phase, modeling and simulation of artificial neural networks as well as genetic algorithms in different tasks about pattern digital signals recognition.
PEK_U02 – can use the environments for project phase, modeling and implementation of expert systems to dedicated fields of knowledge.
PEK_U03 – can use the environments for project phase, modeling and implementation of fuzzy sets and fuzzy reasoning to dedicated fields of knowledge.

PROGRAMME CONTENT

	Form of classes - lecture	**Number of hours**
Lec 1	The idea of intelligent processing	2
Lec 2	Fuzzy sets and approximate reasoning	2
Lec 3	Expert systems - knowledge base organization	2
Lec 4	Expert systems - reasoning rules creation	2
Lec 5	Expert systems: typical organization and applications	2
Lec 6	Artificial neural networks: learning and retrieving algorithms	2
Lec 7	Multilayer perceptron and related networks	2
Lec 8	Self-organizing networks	2
Lec 9	Associative networks	2
Lec 10	GAN and RBF networks	2
Lec 11	Artificial neural networks: applications	2
Lec 12	Genetic algorithms: description and classification	2
Lec 13	Genetic algorithms: basic mechanisms and solutions	2
Lec 14	Genetic algorithms: classical applications	2
Lec 15	Repetition	2
	Total hours	**30**

	Form of classes - project	**Number of hours**
Pro 1	Artificial neural networks - the realization includes the changes of network topology tests and the influence of parameters for network behavior	8
Pro 2	Genetic algorithms in different tasks about pattern recognition, digital signals and data processing – the possible solutions and the influence for the results of the experiment	8

Pro 3	Expert systems creation to dedicated problems	6
Pro 4	Fuzzy sets and fuzzy reasoning – the project phase, modeling, and implementation in different fields of knowledge	8
	Total hours	**30**

TEACHING TOOLS USED
N1. Lecture using slides and multimedia presentation N2. Additional files are available via a dedicated website N3. Thematic discussions using different audio-visual utensils N4. Practical exercises – the project phase, simulation, analysis, and implementation of softcomputing algorithms N5. Consultations N6. Individual work focused on laboratory exercises N7. Individual work about the softcomputing and the final test resume

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	PEK_U01-03	assessment of written reports about each laboratory exercise, evaluation of laboratory preparation and accuracy of the exercise realization
F2	PEK_W01-05	the final test
P = 0.2*F1 + 0.8*F2 REMARK: It is the obligatory to receive both positive forming marks: F1 and F2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] R. Hecht-Nielsen, *Neurocomputing*
[2] M. Caudill, Ch. Butler, *Understanding Neural Networks*
[3] S. Y. Kung, *Digital Neural Networks*
[4] S. N. Sivanandam, S. N. Deepa, *Principles of Soft Computing*
[5] D. A. Waterman, *A Guide to Expert Systems*
[6] D. Zhang, *Parallel VLSI Neural System Design*

SECONDARY LITERATURE:

[1] B. Bouchon Meunier, *Fuzzy Logic and Soft Computing*
[2] O. Castilo, A. Bonarini, *Soft Computing Applications*
[3] E. Damiani, *Soft Computing in Software Engineering*
[4] D. K. Pratihar, *Soft Computing*
[5] A. K. Srivastava, *Soft Computing*

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Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

SUBJECT CARD

Name of subject in Polish	**Zaawansowane systemy baz danych**
Name of subject in English	**Advanced databases**
Main field of study (if applicable)	**Computer Engineering**
Specialization (if applicable)	**Internet Engineering**
Profile:	**academic**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code	**W04ITE-SM4120G**
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		65		
Form of crediting (Examination / crediting with grade)	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 classes (P)			2,5		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.36		1.36		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1. Gain knowledge in design and development (including normalization) of relational databases and high availability database applications as well as development of complex and efficient SQL queries.
C2. Gain knowledge in design of relational databases that ensure integrity and security of data.
C3. Gain knowledge and basic skills in non-relational database management systems.
C4. Gain knowledge in state-of-the-art database management systems and technologies

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 – knows rules of data modelling and normalisation procedures as well as mechanisms that can be used to ensure data integrity in relational database management systems
PEK_W02 – knows how to construct complex and efficient SQL queries
PEK_W03 – knows basic access control and encryption methods
PEK_W04 – knows differences between non-relational and relational database management systems
PEK_W05 – knows the state-of-the-art achievements and developments in database management systems

relating to skills:

PEK_U01 – can write complex SQL query, analyse query execution plan and propose a modification aiming at more efficient execution
PEK_U02 – can apply normalisation procedures
PEK_U03 – can set access privileges for users and groups and propose solutions that allow to improve availability of the database
PEK_U04 – can design relational database structure together with mechanisms that ensure integrity and correctness of data given a description of real application

relating to social competences:
PEK_K01 – is aware how important is proper storage, representation and querying information in database management systems

PROGRAMME CONTENT

Lecture		Number of hours
Lec 1	Introduction to databases, discussion of issues and difficulties related to the representation of information in computer systems	2
Lec 2	Designing database structures, entity relationship diagrams	2
Lec 3-4	Mechanisms for ensuring the structural and semantic correctness of information stored in relational database management systems. Domain, entity, reference integrity.	4
Lec 5	Mechanisms that automate the operation of databases - functions, stored procedures and triggers	2
Lec 6-7	The relational model as a formal method of representing information. Relational algebra, decomposition, functional dependencies, candidate and primary keys, differences between the relational model and relational database management systems	4
Lec 8-9	Normal forms and normalization - anomalies and the need for decomposition, decompositions without loss of data and dependencies, normal forms, normalization procedures.	4
Lec 10-11	Query execution plans and rules for writing efficient SQL queries, indexes and rules for their creation. B/B+-trees, index management procedures, clustered and non-cluster indexes.	4
Lec 12	Acess control in relational database systems. Formal access control models: MAC, DAC, Chinesse Wall, SeaView	2
Lec 13-14	Timeseries databases as an example of non-relational database systems	4
Lec 15	Final colloquium	2
	Total hours	

Laboratory		Number of hours
Lab 1	Introduction, case-study	2
Lab 2	Ensuring semantical correctness of the data, ensuring business rules, development of sample SQL queries	4
Lab 3	Evaluation and analysis of query execution plans, verification how indexes and database objects affect execution plan and performance	4
Lab 4	Transactions, two-phase blocking, rowids, ensuring integrity of data in multiuser environment	4
Lab 5	Encryption, access control, views and other methods to control user privileges. Impact on query performance and execution time	4

Lab 6-7	Database management systems ensuring high availability – tools and comparison of results.	6
Lab 7-8	Non-relational databases – examples	6
	Total hours	

TEACHING TOOLS USED

N1. Traditional lecture with overhead projector
N2. Laboratory tasks
N3. Consultations
N4. Student work – preparation for laboratory
N5. Student work – preparation for final test
N6. Student work – literature review, preparation and presentation of selected topic from the area of advanced database management systems

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	PEK_W03, PEK_U01 ÷ PEK_U04, PEK_K01.	Realization of laboratory tasks, oral answers
F2	PEK_W05	Presentation of selected topics
F3	PEK_W01 ÷ PEK_W05 PEK_U04.	Final test
C = 0,4*F1 + 0,3*F2 + 0,3*F3		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] [1] M. Gertz, S. Jajodia, „Handbook of Database Security – Application and Trends”, Springer, 2008

[2] S. Sumathi, S. Esakkirajan, „Fundamentals of Relational Database Management Systems”, Springer, 2007

[3] B. Schwartz, P. Zaitsev, V. Tkachenko, J.Zawodny, A.Lentz, D.J. Balling, „High Performance MySQL: Optimization, Backups, Replication, and More”, O'Reilly 2008

[4] H.Garcia-Molina, J.Ullman, and J.Widom, „Database Systems: The Complete Book”, 2008

SECONDARY LITERATURE:

[1] [1] C. Bell et al., MySQL High Availability: Tools for Building Robust Data Centers, O'Reilly 2010

[2] D. Litchfield, C. Anley, J. Heasman, B. Grindlay, „The Database Hacker’s Handbook: Defending Database Servers”, Wiley Publishing, 2005

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Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

SUBJECT CARD

Name of subject in Polish	**Programowanie aplikacyjne – eksploracja i hurtownie danych**
Name of subject in English	**Application Programming - Data Mining and Data Warehousing**
Main field of study (if applicable)	**Computer Engineering**
Specialization (if applicable)	**Internet Engineering**
Profile:	**academic**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code	**W04ITE-SM4121G**
Group of courses	**YES / NO***

	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)	50		75	25	
Form of crediting (Examination / crediting with grade)	Crediting with grade		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 classes (P)	-		3	1	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,36		1,36	0,76	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.
2.
3.

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SUBJECT OBJECTIVES

The student who has completed the course should:
C1 Know application areas and design principles of OLAP (Online Analytical Processing) systems.
C2 Be able to design ETL (Extract-Transform-Load) processes, multidimensional databases, multidimensional cubes using a selected development platform (such as MS SQL Server Integration Services (SSIS) and Analysis Services (SSAS)).
C3 Know the purpose and application areas of the most prominent methods of data mining (such as predictive modelling, clustering, association rules mining, time series analysis) in business and scientific problems.
C4 Know the most important statistical and/or machine learning algorithms used in data mining
C5 Know the data mining methodology (such as CRISP-DM).

C6 Be able to implement the data mining process using a selected data mining tool (such as Python scikit-learn).
C7 Be able to fine-tune predictive models in order to meet the requirements in terms of sensitivity / specificity / precision / recall measures
C8 Be capable of self-managed learning of new developments in data mining / machine learning / business intelligence.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEK_W01 Knows application areas and design principles of data warehouse and OLAP systems
PEK_W02 Knows specific requirements for analytical databases and most prominent models of the analytical systems (relational – ROLAP, multidimensional – MOLAP, hybrid - HOLAP)
PEK_W03 Knows design principles of ETL (Extract-Transform-Load) processes
PEK_W04 Knows application areas of most prominent methods of data mining in business and science (including predictive modelling, clustering, association rules mining, Web mining)
PEK_W05 Knows the most important algorithms employed by various methods of data mining
PEK_W06 Knows the data mining methodology applied in business problems (e.g. CRISP-DM)

relating to skills:
PEK_U01 Is able to design a multidimensional reporting system based on data warehouse/multidimensional cubes/OLAP technologies
PEK_U02 Is able to design and implement ETL processes for integration of disparate data sources using MS SQL Server Integration Services (SSIS)
PEK_U03 Is able to implement multidimensional database and multidimensional cubes using MS SQL Server Analysis Services (SSAS)
PEK_U04 Is able to perform analysis of requirements of a business intelligence system and to select appropriate methods of data mining
PEK_U05 Is able to implement data mining process in a selected data mining tool (e.g. Python scikit-learn)
PEK_U06 Is able to fine-tune predictive models in terms of sensitivity / specificity / precision / recall measures

relating to social competences:
PEK_K01 Is able to continue self-managed learning regarding new methods and tools in data mining and business intelligence

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Purpose, application areas, important concepts, architecture of data warehouse / Online Analytical Processing (OLAP) systems, ETL processes	2
Lec 2,3	Analytical database design – data warehouse schemes: relational (ROLAP), multidimensional (MOLAP), hybrid (HOLAP). Data aggregation in multidimensional databases (MDDB). MDX – multidimensional database query language	4

Lec 4	Purpose and application areas of most important methods of data mining in business and science (methods of predictive modelling, clustering, association rules mining, time series analysis)	2
Lec 5	Fundamentals of the statistical learning theory, Bayes classifier, Bayes error. Linear and quadratic discriminant analysis (LDA, QDA). Naïve Bayes, nonparametric classification	2
Lec 6	Linear methods in classification: perceptron algorithm, MLP, B-P algorithm	2
Lec 7	Linear regression, logistic regression. Regularization techniques, ridge regression, Lasso, Elastic-net	2
Lec 8	Decision trees, learning algorithms	2
Lec 9	Support Vector Machine classifier	2
Lec 10-11	Measures of predictive performance (sensitivity, specificity, ROC curve, precision, recall). Model selection, cross-validation. Learning in high dimensional data, dimensionality reduction (wrapper, filter methods, multiple testing correction), PCA algorithm, RFE method	4
Lec 12	Algorithms for association rules mining, applications	2
Lec 13-14	Unsupervised learning - clustering algorithms: kNN, hierarchical algorithms, vector quantization, SOM, DBSCAN; applications in anomaly/outlier/novelty detection	4
Lec 15	Open set classification, out-of-distribution detection in high dimensional representations. Learning from class-imbalanced data.	2
	Total hours	30

Laboratory		**Number of hours**
Lab 1,2	Introduction to MS SQL Server Integration Services (SSIS) and Analysis Services (SSAS)	4
Lab 3,4	Design and implementation of the ETL process in SSIS tool	4
Lab 5,6	Design and implementation of the multidimensional model of data – fact and dimension tables, OLAP cubes – implementation in SSAS tool, deployment of the OLAP cubes in Analysis Services database engine.	4
Lab 7,8	Introduction (tutorial) to selected machine learning / data mining system (Python scikit-learn, Jupyter lab)	4
Lab 9,10	Implementation of the data mining process for the task of classification - baseline solutions using different classification algorithms (decision trees, random forest, neural networks, logistic regression, memory-based learning, etc.). Estimation of predictive performance– sensitivity, specificity, ROC curves. Model selection, fine-tuning model capacity	4
Lab 11-12	Model selection – using dimensionality reduction / feature selection methods	4
Lab 13-15	Model selection – using techniques for class-imbalanced data. Bagging, boosting	6
	Total hours	30

Project		**Number of hours**
Proj 1,2	Introduction to project tasks / requirements (supervised learning based on high-dimensional data and/or class-imbalanced data)	2
Proj 3-13	Realization of project tasks	11
Proj 14,15	Presentation / discussion of project results	2
	Total hours	**15**

TEACHING TOOLS USED

N1. Lecture, power point presentations, handouts
N2. Laboratory classes
N3. Consultations
N4. Self-study – preparation for the laboratory classes
N5. Self-study – preparation for the lab tasks
N6. Self-study – preparation for the 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	PEK_U01-PEK_U06 PEK_K01	Evaluation of the laboratory tasks; discussion of results with students
F2	PEK_U01 - PEK_U06 PEK_K01	Evaluation of project results basen on reports and presentations
F3	PEK_W01 ÷ PEK_W06	Final test (written)
P = 1/3*F1 + 1/3*F2 + 1/3*F3		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] T. Hastie, R. Tibshirani, J. H. Friedman, The Elements of Statistical Learning : Data Mining, Inference, and Prediction, Second Edition , Springer
[2] J. Han, M. Kamber, Data Mining: Concepts and Techniques, Second Edition, Elsevier

SECONDARY LITERATURE:

[1] J. Koronacki, J. Ćwik, Statystyczne systemu uczące się, WNT
[2] T. Hastie, R. Tibshirani, M. Wainwright, Statistical Learning with Sparsity. The Lasso and Generalizations. CRC Press
[3] M. Krzyśko i in., Systemu uczące się. Rozpoznawanie wzorców, analiza skupień i redukcja wymiarowości. WNT
[4] S. Theodoridis, K. Koutroumbas, Pattern Recognition, Elsevier
[5] G. James i in., An Introduction to Statistical Learning, with Application in R, Springer
[6] H.P. Langtangen, Python Scripting for Computational Science, Springer

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Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

SUBJECT CARD

Name of subject in Polish	**Programowanie aplikacyjne urządzeń mobilnych**
Name of subject in English	**Application Programming - Mobile Computing**
Main field of study (if applicable)	**Computer Engineering**
Specialization (if applicable)	**Internet Engineering**
Profile:	**academic**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code	**W04ITE-SM4112G**
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)	70		70		35
Form of crediting (Examination / crediting with grade)	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 classes (P)			3		1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,36		1,36		0,68

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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SUBJECT OBJECTIVES

C1 Acquisition of knowledge about: construction, use, and typical applications of mobile consumer devices (multimedia phones, smartphones, tablets).

C2 The acquisition of specific knowledge about: the design and mobile application software aspects: mobile user interface, mobile communications, mobile networks, mobile databases, multimedia, embedded operating systems, embedded sensors and mobile security.

C3 Acquiring the ability to create applications for the selection of most popular mobile platforms (Android and iOS).

C4 Acquiring the ability to carry out the full production cycle, of a distributed computer system, using mobile devices with the selected OS.

C5 Acquiring the ability of searching and self-studying the technical documentation of new systems and technologies in the field of mobile software.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 knows the structure and characteristic hardware limitations of mobile devices

PEK_W02	is able to characterize and compare at least five different platforms, operating systems and programming IDE for mobile software development
PEK_W03	knows the principles of user interface design for smartphones and tablets
PEK_W04	has the knowledge of mobile databases
PEK_W05	has the knowledge of mobile telecommunications and mobile networks
PEK_W06	has the knowledge of typical sensors, embedded in mobile devices
PEK_W07	is familiar with security issues in distributed IT systems composed of mobile devices
PEK_W08	knows the principles of design and implementing a complex system using mobile devices.
relating to skills:	
PEK_U01	is able to design and implement sample applications for at least three standard mobile platforms (Android, iOS)
PEK_U02	Can use a selection of most popular development environments for mobile devices: Android Studio, XCode
PEK_U03	can implement the mobile database with SQLite standard
PEK_U04	can implement the mutual communication between mobile devices and a central server using TCP/IP standard
PEK_U05	can program the mobile communication (GSM / UMTS) unit, transmission of different messages: SMS, MMS and Email
PEK_U06	can program the embedded sensors (accelerometer, magnetometer, gyroscope, GPS) and utilize geomaping or geolocation services
PEK_U07	is able to prepare and configure the software distribution process through the online store (Google Play or Apple App Store)
relating to social competences:	
PEK_K01	recognizes the importance of information retrieval skills, and continuous studying of fast alternating field of mobile technologies.
PEK_K01	understands the need to develop the capacity for critical analysis and independent use of the acquired knowledge and skills.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Introduction. Types of mobility. Characteristic features and hardware limitations of mobile devices. The evolution of mobile devices, networks and services. Overview of mobile platforms, operating systems, architectures and typical applications.	2
Lec 2	Android OS operating system and development environment. Open Handset Alliance. Android OS architecture. System versioning. Configuration of the Android Studio development environment and SDK.	2
Lec 3	Android part II. Standard Android application components: Activity, Intent, Service, BroadcastReceiver, ContentProvider. Life cycle of mobile application and Activity objects.	2
Lec 4	Android part III. User interface design and implementation (View, ViewGroup, XML Layouts, Widget components). Techniques of UI adaptation to various display orientations and technical configurations of devices.	2
Lec 5	Android part IV. Data archiving: preferences, XML files, implementation of a mobile database using SQLite. Network communication and data transfer using: sockets, TCP/IP/HTTP and Telephony API protocols.	2
Lec 6	Android Fragments and the use of Jetpack architectural components (ViewModel, LiveData, DataBinding, LifecycleObserver)	2

Lec 7	Apple iOS operating system and environment. iOS system architecture, Xcode environment, Swift language. User interface design using Cocoa Touch, UIKIt and Foundation Framework.	2
Lec 8	Programming applications for iOS part II. MVC architecture. Lifecycle of ViewController components and applications. Multi-window apps: Storyboard, Segues.	2
Lec 9	Programming applications for iOS part III. Master-Detail pattern, UITableViewController. Procedures for preparing the publication of code and data via the AppStore.	2
Lec 10	Programming iOS applications using SwiftUI	2
Lec 11	Mobile databases. Systems of local data archiving in flash memory and on SD cards. Data synchronization. Overview of commercial solutions: SQLite, Sybase SQL Anywhere, IBM DB2 Everyplace	2
Lec 12	Web services. Standards and protocols: SOAP, WSDL, UDDI. Tools and libraries supporting the creation of web services: JDeveloper, JAX-RPC, SOAP::Lite, gSOAP, Python/ZSI	2
Lec 13	Security of mobile systems. Common threats, vulnerabilities and wireless attack scenarios. Security technologies for mobile systems and networks.	2
Lec 14	Development trends in the field of mobile technologies. Alternative technologies for developing applications for mobile devices - selected cross-platform frameworks (ReactNative, Flutter, Xamarin)	2
Lec 15	Repetition and final test.	2
	Total hours	30

Laboratory		**Number of hours**
Lab 1	Organizational activities. Health and safety rules - training. Discussion of topics and the way of carrying out laboratory exercises.	2
Lab 2	Android - introduction, Android Studio development environment, Android SDK and AVD configuration. Application testing with emulators and physical mobile devices.	2
Lab 3	Android (2) - testing/debugging the activity lifecycle. Implementation of the "Currency Converter" demo application	2
Lab 4	Android (3) – designing an responsive / adaptive user interface for different device screen sizes, resolutions and orientations.	2
Lab 5	Android (4) - exercises in programming a multi-screen application consisting of several activities. Controlling the flow of the Activities using intentions and commands startActivity, startActivityForResult.	2
Lab 6	Android (5) - exercises with applications utilizing celular communication: Telephony API, communication using SMS, MMS, Email, network data transmission and monitoring the status of the GSM module.	2
Lab 7	Android (6) - exercises with applications using RecycleView and access to the SQLite database using SQLiteDatabase, SQLiteOpenHelper or Room ORM.	2
Lab 8	Selection of a topic for individual project. Developing a concept for a project task that requires independent familiarization with a selected issue in the field of mobile technologies (mobile database, support for built-in sensors, network communication, 3D graphics or generating 2D animations)	2
Lab 9-10-11	Continuing the implementation of the selected individual project (from La8)	6

Lab 12	Apple iOS - getting familiar with the iOS platform and the MacOS, Xcode development environment and the Swift programming language. Implementing simple application of a single-screen currency converter.	2
Lab 13	iOS (2) – Exercises illustrating the role of controllers in the MVC / MVVC architecture. Test implementation of methods for all stages of the controller life cycle with visualization using control printouts. Using Segue to manage switching between views (controllers) of a multi-screen application.	2
Lab 14	iOS (3) – Implementation of a complex application using TableViewController and the Master-Detail pattern.	2
Lab 15	iOS (4) – application development using SwiftUI	2
	Total hours	30

Seminar		**Number of hours**
Semin 1	Organizational activities. Discussion of topics and the way of carrying out laboratory exercises.	1
Semin 2	Presentation of selected seminar problems	7x2
	Total hours	15

TEACHING TOOLS USED

N1. Traditional lecture using video projector.
N2. Individual work - development and implementation of introductory laboratory.
N3. Individual work - concept development, implementation and documentation of final laboratory task.
N4. Overview / code inspection made by the laboratory instructor.
N5. Presentation and discussion of the selected topic in front of the group.
N6. Individual work - self-study and preparation for the written test.
N7. 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	PEK_W01 – W08	Written test during the last lecture
F2	PEK_U01 – U07	Evaluation of introductory exercises. Inspection of created software code. Assessment of reports documenting the execution of tasks. Analysis of the concept and the technical documentation created by the student. Quality inspection of provided final project code, by the laboratory instructor.
F3	PEU_K01 – K02	Evaluation of presentations and discussions of selected seminar topics
P = 0.4*F1 + 0.4*F2 + 0.2*F3; All partial evaluations must be positive: F1≥3.0 , F2≥3.0 , F3≥3.0		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] T. Mikkonen, "Programming mobile devices: an introduction for practitioners"

[2] W.F. Ableson, R. Sen, C. King, "Android in Action",

[3] S. Conder, L. Darcey: "Wireless Application Development ",

[4] M. Piasecki, "Mobile Computing",

[5] T. Mikkonen, "Programming mobile devices: an introduction for practitioners"

SECONDARY LITERATURE:

[1] e-book / Techotopia – “Android Studio Giraffe Development Essentials”

[2] e-book / Answertopia – “iOS 16 App Development”

[3] I.F. Darwin “Android. Recipes"

[4] M. Wooten, "Java Web Services",

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

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