Zał. nr 5 do ZW 16/2020

FACULTY of Information and Telecommunication Technology

SUBJECT CARD

Name of subject in Polish: Zaawansowane sieci komputerowe
Name of subject in English: Advanced Computer Networks
Main field of study (if applicable): Applied Computer Science
Specialization (if applicable): Computer Engineering
Profile: academic
Level and form of studies: 2nd level, full-time studies
Kind of subject: obligatory
Subject code: W04IST-SM4102G
Group of courses: YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	90		90		
Form of crediting	Crediting with grade		Crediting with grade		
For group of courses mark final course with (X)	X				
Number of ECTS points	3		3		
including number of ECTS points for practical (P) classes			3		
including number of ECTS points for direct teacher-student contact (BU) classes	1,8		1,8		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has basic knowledge of Computer Networking.
2. Has basic knowledge of Windows Server, Linux and Cisco IOS operating systems.
3. Has basic knowledge of programming languages.

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SUBJECT OBJECTIVES

C1. Acquire theoretical principles for planning and configuration of selected network technologies and services in enterprise environment.
C2. Acquire practical skills for planning and configuration of selected network technologies and services in enterprise environment.

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01 – student has knowledge on selected network technologies and services.

relating to skills:

PEU_U01 – student has basic skills in the planning and configuration of selected network technologies and services.

PEU_U02 – student has the preparation necessary to work in computer laboratories and knows the rules of safety associated with this work.

PROGRAM CONTENT

	Lectures	**Number of hours**
Lec 1	ISO/OSI and TCP/IP model.	2
Lec 2	Network IPv4 and IPv6 addressing.	2
Lec 3	Configuration of network devices using CLI interface.	2
Lec 4	Static routing.	2
Lec 5	VLAN and trunk.	2
Lec 6	VLAN routing.	2
Lec 7	Dynamic routing.	2
Lec 8	Network firewalls on the example of Access Control List (ACL).	2
Lec 9	Virtual Private Networks on the example of GRE tunnel.	2
Lec 10	Network virtualization.	2
Lec 11	Security of network communication.	2
Lec 12	Network threat detection and traffic controll.	2
Lec 13	Software Definied Networks.	2
Lec 14	HTTP REST API technology	2
Lec 15	Network programming.	2
	Total hours	30

	Laboratory	**Number of hours**
Lab 1	Introduction to laboratory.	2
Lab 2	Network addressing exercises.	2
Lab 3	Network devices configuration using CLI interface.	2
Lab 4	Static routing.	2
Lab 5	VLAN and trunk	2
Lab 6	VLAN routing	2
Lab 7	OSPF routing.	2
Lab 8	Network firewall. Extended ACL.	2
Lab 9	VPN network using GRE tunneling protocol.	2
Lab 10	Network virtualization. Linux Debian VM. Virtual router.	2
Lab 11	Securing a network communication. SSH, SSL, IPsec.	2
Lab 12	Network threat detection and traffic control. Port mirroring.	2
Lab 13	Software Defined Networks.	2
Lab 14	Network configuration using HTTP REST API interface	2
Lab 15	Network configuration using Python script.	2

	Total hours	30

TEACHING TOOLS USED

N1. Lecture
N2. Laboratories with access to network devices and server operating systems with administrative privileges.
N3. Network simulator – remote preparation to laboratories.
N4. Network applications.
N5. Student work – Preparation to laboratories.
N6. Student work – Preparation to Exam.
N7. Consultation.
N8. Written tests.

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	Colloquium. To pass, a student must earn more than half of the points available during the exam. The lecturer can award additional points for the activity during lectures during the semester. The F1 grade is the partial grade.
F2	PEU_U01	Points for each of test during semester. To pass, a student must earn more than half of the points available during the semester. The lecturer can award additional points for the activity during laboratories during the semester. The F2 grade is the partial grade.
F3	PEU_U02	Mandatory participation in the training conducted by the lecturer. Pass on the basis of participation.
P		The final grade for the group of courses is the arithmetic mean of F1 and F2. wherein the student must pass F1, F2, and F3, which means that both of the partial grades F1 and F2 must be positive and F3 passed.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Tanenbaum A.S.: Computer Networks, Prentice Hall, 2002.
[2] Mir N. F.: Computer and Communication Networks, Prentice Hall, 2006.
[3] Comer D.E.: Computer Networks and Internets with Internet Application, Prentice Hall, 2004.
[4] Kurose J., Ross K., Addison W.: Computer Networking: A Top-Down Approach, 5th edition, 2009.
[5] Cisco Academy Curriculums: CCNA, CCNAS

SECONDARY LITERATURE:

[1] RFC documents on http://www.rfc-editor.org

[2] Linux documentation project http://tldp.org
[3] Technical documentation on http://technet.microsoft.com
[4] Ying-Dar Lin, Ren-Hung Hwang, Baker F.: Computer Networks: An Open Source Approach, McGraw-Hill, 2012
[5] Erickson J.: Hacking: The Art of Exploitation, 2nd Edition, ISBN-13: 978-1593271442
[6] Cyber Operations: Building, Defending, and Attacking Modern Computer Networks, Released November 2015, Apress, ISBN: 9781484204573
[7] Cisco Academy Curriculums: Cyber-ops, Python

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

Kamil Nowak, kamil.nowak@pwr.edu.pl

*delete if not necessary

Zał. nr 5 do ZW 16/2020

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): Applied Computer Science
Specialization (if applicable): Computer Engineering
Profile: academic
Level and form of studies: 2nd level, full-time studies
Kind of subject: obligatory
Subject code: W04IST-SM4002G
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)	60			120	
Form of crediting	crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	crediting with grade*	~~Examination~~ / crediting with grade*
For group of courses mark final course with (X)	X				
Number of ECTS points	2			4	
including number of ECTS points for practical (P) classes	0			4	
including number of ECTS points for direct teacher-student contact (BU) classes	1,2			2,4	

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of elementary data models and database design methods
2. Elementary knowledge of Database architectures
3. Elementary knowledge of SQL

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SUBJECT OBJECTIVES

C1 To enhance students' knowledge about modern data models
C2 To learn how to practically apply modern data models in advanced database applications

SUBJECT LEARNING OUTCOMES

relating to knowledge:
PEU_W01 Has a basic knowledge about advanced data models
PEU_W02 Is able to present and evaluate usages of advanced data models

relating to skills:

PEU_U01 Is able to apply modern methods of improving the efficiency of data storage and processing.
PEU_U02 Is able to use advanced data models in the design and development of database applications.

PROGRAM CONTENT

	Lectures	**Number of hours**
Lec 1	Introduction. Architecture of DBMS	2
Lec 2	Data storage and ensuring efficient data access	2
Lec 3	Query processing and optimization	2
Lec 4	Transactions processing	2
Lec 5	Columnar data storage and compression	2
Lec 6	Temporal data processing	2
Lec 7	Stream data processing	2
Lec 8	Test	1
	Total hours	15

	Project	**Number of hours**
Proj 1	Introduction, Building of projects teams.	2
Proj 2	Formulation of topic and scope of project and tools used.	2
Proj 3	Design and implementation of test database.	6
Proj 4	Tests of enhanced data models (3 iterations, 6h each)	18
Proj 6	Presentation, discussion and grading.	2
	Total hours	30

TEACHING TOOLS USED

N1. Lecture
N2. Individual consultations
N3. The course web page with references to literature
N4. Software development tools
N5. DBMS

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 – Project	PEU_U01, PEU_U02,	Avg. of grades for each project phase

F2- Lecture	PEU_W01, PEU_W02,	Test
P		F1 * 0.5 + F2 * 0.5

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] C.J. Date, Date on Database, Writings 2000-2006, Apress, 2006
[2] R. Elmasri, S. B. Navathe, Fundamentals of Database Systems , Fourth Edition, Addison-Wesley, 2003
[3] R. Ramakrishnan, J. Gehrke, Database Management Systems, McGraw-Hill, 2000

SECONDARY LITERATURE:

[1] J. Gamper, et. al. Temporal Data Management: An Overview, eBISS 2017
[2] Arasu, A. and Babcock, B. and Babu, S. and Cieslewicz, J. and Datar, M. and Ito, K. and Motwani, R and Srivastava, U. and Widom, J. (2004) STREAM: The Stanford Data Stream Management System. Technical Report. Stanford InfoLab.
[3] Stavros Harizopoulos, Daniel Abadi, Peter Boncz, Column-Oriented Database Systems, VLDB 2009

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

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*delete if not necessary

Zał. nr 5 do ZW 16/2020

FACULTY of Information and Communication Technology

SUBJECT CARD

Name of subject in Polish: Zaawansowane elementy sztucznej inteligencji
Name of subject in English: Advanced Topics in Artificial Intelligence
Main field of study (if applicable): Applied Computer Science
Specialization (if applicable): Computer Engineering
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W04IST-SM4003G
Group of courses: YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30			30	
Number of hours of total student workload (CNPS)	90			120	
Form of crediting	Examination / ~~crediting with grade~~*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*
For group of courses mark final course with (X)					
Number of ECTS points	4			3	
including number of ECTS points for practical (P) classes	0			3	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	2.4			1.8	

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Proficiency in programming
2. Ability to use scientific literature
3. Teamwork skills

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SUBJECT OBJECTIVES

C1. Extend and deepen the knowledge of intelligent methods, their uses and methods of validation
C2. The ability to select appropriate intelligent techniques and their validation to the task

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 Awareness of the role of creative thinking and knowledge representation
PEU_W02 Issues connected with Machine Learning task

PEU_W03 Issues connected with imprecise knowledge
relating to skills:
PEU_U01 The ability to formulate problems in a way that facilitates its solution
PEU_U02 Skilful selection of intelligent techniques to the given problem
PEU_U03 The intelligent processing of imprecise knowledge
relating to social competences:
PEU_K01 Cooperation in group

PROGRAM CONTENT

	Lectures	**Number of hours**
Lec 1	Introduction to the course. Discussion: what is AI? A historical perspective and recent trends	2
Lec 2	Problems: representation, re-representation and solving	2
Lec 3	Machine learning - The learning problem, is learning feasible? Basic concepts, types of learning	2
Lec 4	Feature reduction methods (selection and transformation)	2
Lec 5	Support Vector Machine	2
Lec 6	Multi-label classification	2
Lec 7	Ensemble of classifiers	2
Lec 8	Reinforcement Learning – selected issues	2
Lec 9	Clustering: hierarchical clustering, clustering ensembles, subspace clustering	2
Lec 10	Reasoning with uncertainty – rough sets theory (part 1)	2
Lec 11	Reasoning with uncertainty – rough sets theory (part 2)	2
Lec 12	Granular Computing – introduction, example	2
Lec 13	Knowledge Data Discovery (KDD Process) and generation of the association rules	2
Lec 14	Evolutionary computation in data mining tasks or students projects presentations	2
Lec 15	Ethics problems in Artificial Intelligence – Explainable AI	2
	Total hours	30

	Project	**Number of hours**
Proj 1	Discussion about possible subjects of the project, teams, requirements	2
Proj 2	Decision and consultation about the project subject, its scope, etc.	2
Proj 3	Detailed plan of the project, consultation of used methods, approaches, etc.	6
Proj 4	Projects plan and progress presentation	4
Proj 5	Project realization and consultation	10
Proj 6	Student presentations of the project results	4
Proj 7	Summarization of the presented projects	2
	Total hours	30

TEACHING TOOLS USED

N1. Presentations with projectors
N2. E-learning system used for the publication of teaching materials

N3. On-line lectures, if needed N3. Discussions

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), C – concluding (at semester end)	Learning outcomes number	Way of evaluating learning outcomes achievement
F1 Project presentation in the middle of semester	PEU_U01 PEU_U02	Student can receive 10 point max. The presentation of the problem itself and the planned approach to solve the problem is evaluated.
F2 Presentation of the final results of the project	PEU_U02 PEU_U03 PEU_K01	Student can receive 20 point max. The presentation of the problem itself and the planned approach to solve the problem is evaluated.
P1 Final grade of the project	PEU_U02 PEU_U03 PEU_K01	Points for the presentations and additional 10 points for the student's activity during the semester is summed. The final evaluation will be issued in accordance with the following scale: % of points: grade [0%, 50%]: 2.0 [50%+1 point, 60%): 3.0 [60%, 70%): 3.5 [70%, 80%): 4 [80%, 90%): 4.5 [90%, 100%]: 5.0
P2	PEU_W01 PEU_W02 PEU_W03	Exam. The exam is a written exam, checking knowledge of the lecture and the ability for practical use of this knowledge. It consists of test questions. The student to pass the course should obtain more than 50% of all possible points (50%+1 point). % of points: grade [0%, 50%]: 2.0 [50%+1 point, 60%): 3.0 [60%, 70%): 3.5 [70%, 80%): 4 [80%, 90%): 4.5 [90%, 100%]: 5.0
C: The arithmetic mean of the project and exam grades. The result is rounded up towards the exam grade.		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Literature items indicated during lectures, indicated on the slides for these lectures, like e.g.: „An Analysis of Quantitative Measures Associated with Rules", https://www.researchgate.net/publication/220894386_An_Analysis_of_Quantitative_Measures_Associated_with_Rules, "Induction of Classification Rules by Granular Computing". J.T. Yao and Y.Y. Yao. http://www2.cs.uregina.ca/~yyao/PAPERS/rsctc02_yy.pdf
[2] MAIMON O., ROKACH L.: Data Mining and Knowledge Discovery Handbook. Springer, 2006.
[3] Mitchell Tom M., Machine Learning. McGraw-Hill companies, Inc., 1997.

SECONDARY LITERATURE:

Any current scientific article or book relevant to the course topic

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

FACULTY Faculty of Information and Communication Technology /

SUBJECT CARD

Name of subject in Polish: Analiza systemów webowych
Name of subject in English: Analysis of Web-based Systems
Main field of study (if applicable): Applied Informatics
Specialization (if applicable): Computer Engineering
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W04IST-SM4005G
Group of courses: YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	120		90		
Form of crediting	Examination	Examination / crediting with grade*	crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	4		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)	2,4		1,8		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of mathematical analysis
2. Basic knowledge and skills of programming

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SUBJECT OBJECTIVES

C1 Familiarize students with current knowledge in the field of Web-based systems
C2 Presentation of Web-based systems performance prediction approaches and methods
C3 Familiarize students with web data mining methods
C3 Presentation of Web-based systems performance prediction approaches and methods
C4 Obtaining skills in the development and analysis of web performance data

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 Knows and understands the basic processes taking place in the life cycle of facilities and IT systems
PEU_W02 knows the methods of representation of models used in computer science

relating to skills:
PEU_U01 Students can plan and carry out experiments, analyze and interpret the obtained results, and draw conclusions

relating to social competences:
PEU_K01 Is ready to critically evaluate the received content and is aware of the importance of knowledge in solving problems.
PEU_K02 Can think and act creatively and enterprisingly.

PROGRAMME CONTENT

Lecture		Number of hours
Lec 1	Introduction to the course. Description of the course, the organization of classes and examination. Basics of Internet.	2
Lec 2	Internet architecture and infrastructure	2
Lec 3	TCP/IP protocol stack, Distance metrics.	2
Lec 4	TCP transport, DNS	2
Lec 5-6	HTTP - current and future developments	4
Lec 7-8	Web traffic characteristics	4
Lec 9-10	Web performance issues	4
Lec 11-12	Web performance prediction.	4
Lec 13-14	Web mining. Web performance mining	4
Lec 15	Auction methods in the analysis of Web-based systems	2

	Total hours	30

Laboratory		Number of hours
Lab 1	Rules for completing the course, the definition of the lab tasks	2
Lab 2	Web performance analysis, presenting the data collection process from Webpagetest tool, discussing the experiment: storing and analyzing the real data (i.e. load time, time to first byte)	2
Lab 3	Continuation of the web performance experiment	2
Lab 4	Continuation of the web performance experiment	2
Lab 5	Prediction of data based on online shop logs using Orange Data Mining tool	2
Lab 6	Continuation of prediction process (Orange tool)	2
Lab 7	Prediction of data based on online shop logs using Weka Data Mining tool	2
Lab 8	Continuation of prediction process (Weka tool)	2
Lab 9	Preprocessing of logs (including inconsistent data)	2
Lab 10	Continuation of preprocessing process	2
Lab 11	Prediction process based on full set (large) off cleaned data for different number of input parameters	2
Lab 12	Continuation of prediction based on a large set of data	2
Lab 13	Data prediction for the proposed tool for a different number of input parameters	2
Lab 14	Continuation of data prediction for proposed tool	2
Lab 15	Summarisation of reports	2
	Total hours	30

TEACHING TOOLS USED

N1. Lectures supported by multimedia presentations
N2. Multimedia presentations
N3 Scientific and technical publications, including own research
N4. E-learning system used for publication of teaching materials, announcements, collection and assessment of student works
N5. Student's own work - realization of a lab task in a group
N6. Additional consultations for students.

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	KIST_W02, KIST_W07,	Checking student preparation for the laboratory. Evaluation of the progress of performed experiments, analysis of results, and conclusion. Observation of

	KIST_U03	student activity and teamwork.
F2	KIST_U03, KIST_K01, KIST_K02	Student uses knowledge in solving problems. Students can define experiments, conduct and evaluate it

P Laboratory produces the L grade. The test running on the WUST e-Portal online system is used to evaluate the lecture. Grade E is obtained, then. The Final Grade C is calculated as the average value of both grades: E and L, C=(E+L)/2.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Ilya Grigorik, High-Performance Browser Networking, O'Reilly 2013, http://chimera.labs.oreilly.com/books/1230000000545/index.html
[2] Candace Leiden, Marshall Wilensky. TCP-IP For Dummies 6 Edition Wiley,2009
[3] Literature recommended on an ongoing basis by the lectures

SECONDARY LITERATURE:

[1] Documentation of tools: https://www.webpagetest.org/, https://orangedatamining.com/, https://www.cs.waikato.ac.nz/ml/weka/

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

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Zał. nr 5 do ZW 16/2020

FACULTY of Information and Communication Technology

SUBJECT CARD

Name in Polish **Hurtownie Danych**
Name in English **Data Warehouses**
Main field of study (if applicable): Applied Computer Science
Specialization (if applicable): **Computer Engineering**
Profile: **academic**
Level and form of studies: **2nd level, full-time studies***
Kind of subject: **obligatory**
Subject code **W04IST-SM4107G**
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)	**90**		**90**	**30**	
Form of crediting	Examination		Examination	Examination	
For group of courses mark final course with (X)	**X**				
Number of ECTS points	**3**		**3**	**1**	
including number of ECTS points for practical (P) classes			**3**	**1**	

including number of ECTS points for direct teacher-student contact (BK) classes	**1,8**		**1,8**	**0,6**	

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of database system, with a particular focus on the relational model.
2. At least basic knowledge of SQL query language

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SUBJECT OBJECTIVES

c1. Has basic knowledge on Business Intelligence systems.
c2. Has basic knowledge on transaction oriented processing (OLTP) and analytic oriented processing (OLAP).
c3. Has basic skills of determining type of processing (transaction vs analytic), including the ability to determine business needs and requirements.
c4. Has basic knowledge on multidimensional data model and basics of data warehousing
c5. Has basic skills of data warehouse usage, including design of data warehouses
c6. Has basic knowledge on data integration, reporting and visualisation
c7. Has basic skills of data integration process design
c8. Has basic skills of report generation and analysis
c9. Has basic knowledge on data analysis
c10. Has basic skills of data analysis tools usage

SUBJECT LEARNING OUTCOMES

relating to knowledge:
PEU_W01 has basic knowledge on Business Intelligence
PEU_W02 has basic knowledge on data warehouses, including data warehouse design
PEU_W03 has basic knowledge on data integration process
PEU_W04 has basic knowledge on reporting and data analysis

relating to skills:
PEU_U01 can design and implement data integration process
PEU_U02 can design and implement basic data warehouse
PEU_U03 can conduct basic data analysis
PEU_U04 can design and implement simple reports, including different data visualisation methods
PEU_U05 observes occupational health and safety rules

relating to social competences:
PEU_K01 can acquire information from literature, and/or search for other sources
PEU_K02 understands the need for regular and constant work focused on course's material
PEU_K03 can identify basic usage of data warehouses, reporting and data visualization in different business processes

PROGRAM CONTENT

	Lectures	**Number of hours**
Lec 1	Course details Business Intelligence – needs, data, issues and systems	3
Lec 2	Transaction vs analytic needs, processes and data sources	2
Lec 3	Multidimensional data model, Basics of data warehousing	2

Lec 4	Data warehouse – architecture and design (including multidimensional modelling)	4
Lec 5	ETL process	2
Lec 6	Data analysis, reporting and visualisation	2
	Total hours	**15**

Laboratory		**Number of hours**
Lab 1	Course Details (Health and Safety Training, Course requirements)	1
Lab 2	SQL basics	1
Lab 3	Analysis of analytical needs Analysis of operational databases	2
Lab 4	ETL process – data extraction	2
Lab 5	ETL process – implementation, data transformation	6
Lab 6	Multidimensional data implementation – ROLAP ETL process – data loading	4
Lab 7	Analytical processing – SQL	2
Lab 8	Multidimensional data implementation – MOLAP ETL process –data loading	4
Lab 9	Using MOLAP	2
Lab 10	Analytical processing – MDX	2
Lab 11	Reporting and data visualisation	2
Lab 12	Basics of data analysis	2
	Total hours	**30**

Project		**Number of hours**
Proj 1	Course details.	1
Proj 2	Operational data analysis – data sources for data warehouse	2
Proj 3	Analytical needs analysis, Multidimensional data design	2
Proj 4	ETL process design and implementation	2
Proj 5	Data warehouse design	2
Proj 6	Data warehouse implementation	2
Proj 7	Reporting and data visualisation design and implementation	2
Proj 8	Data analysis design and implementation	2
	Total hours	**15**

TEACHING TOOLS USED

N1. Lecture – traditional method with multimedia content
N2. Group work – discussion.
N3. Computer laboratory – traditional method with multimedia content
N4. Student's individual work – preparations to laboratories, literature studies

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during	Learning outcomes number	Way of evaluating learning outcomes achievement

semester), P – concluding (at semester end)		
F1	PEU_U01-PEU_U06	Student assessment – individual discussion including laboratory result presentation, conclusions, etc.
F2	PEU_U01-PEU_U06	Student assessment – individual discussion including project result presentation, conclusions, etc.
P1	PEU_W01-PEU_W04	Test
P2	PEU_U01-PEU_U06	Student assessment – summary

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

1. Adamson C., Star Schema: The Complete Reference, Mc-Graw Hill Osborne Media, 2010
2. Vaisman A., Zimányi E., Data Warehouse Systems, Springer-Verlag Berlin Heidelberg, 2014
3. Jensen C.S., Pedersen T.B., Thomsen C., Multidimensional Databases and Data Warehousing, Morgan & Claypool Publishers, 2010
4. Han J., Kamber M., Pei J., Data Mining: Concepts and Techniques, Morgan Kaufmann, 2011
5. Jarke M., Lenzerini M., Vassiliou Y., Vassiliadis P., Fundamentals of Data Warehouses, Springer-Verlag Berlin Heidelberg 2003
6. Inmon W., Building the Data Warehouse, John Wiley & Sons, New York 2002
7. Kimball R., Caserta J., The Data Warehouse ETL Toolkit, Wiley Publishing, Inc, 2004
8. Jukic N., Vrbsky S., Nestorov S., Database Systems: Introduction to Databases and Data Warehouses, Prospect Press, 2016

SECONDARY LITERATURE:

1. Rainardi V., Building a Data Warehouse With Examples in SQL Server, Apress, 2008
2. Harinath S., Pihlgren R., Lee D.G.-Y., Sirmon J., Bruckner R.M., PROFESSIONAL MICROSOFT® SQL SERVER® 2012 ANALYSIS SERVICES WITH MDX AND DAX, John Wiley & Sons, Inc., 2012
3. Microsoft SQL Server 2012 Integration Services, APN Promise, 2012
4. Aspin A., SQL Server 2012 Data Integration Recipes, Apress, 2012
5. Leonard A., Masson M., Mitchell T., Moss J.M., Ufford M., SQL Server 2012 Integration Services Design Patterns, Apress, 2012
6. Imhoff C., Galemmo N., Geiger J.G., Mastering Data Warehouse Design, Wiley Publishing, Inc., 2003
7. MacLennan J., Tang ZH., Crivat B., Data Mining with SQL Server 2008, Wiley Publishing, Inc, 2009
8. Linstedt D., Olschimk M., Building a Scalable Data Warehouse with Data Vault 2.0, Morgan Kaufmann 2015

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

Wojciech Lorkiewicz, wojciech.lorkiewicz@pwr.wroc.pl

Zał. nr 5 do ZW 16/2020

FACULTY of Information and telecommunication technology

SUBJECT CARD

Name of subject in Polish: Seminarium dyplomowe
Name of subject in English: Diploma seminar
Main field of study (if applicable): Applied Computer Science
Specialization (if applicable): Computer Engineering
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W04IST-SM4013S
Group of courses: NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)					30
Number of hours of total student workload (CNPS)					60
Form of crediting	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / 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)					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)					1,2

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge and competences in research methods and tools applied in the discipline of technical informatics and telecommunication.

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SUBJECT OBJECTIVES

C1 To search, analyze and present specialized knowledge in the field of applied computer science
C2 To acquire related social competencies

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

relating to skills:
PEU_U01 - is able to study a specified part of topics in applied computer science
PEU_U02 - is able to present the studied part of the subject matter in the field of applied

computer science, and is able to lead a discussion with the audience on the studied subject matter

relating to social competences:

PEU_K01 - is ready to critically evaluate the received content and is aware of the importance of knowledge in problem solving

PROGRAMME CONTENT

	Seminar	**Number of hours**
Se 1	Discussion of the topics of student study (research) papers, how to study the topics, preparation of research documentation and presentations. Acquisition of topics for student research papers.	2
Se 2 – Se 14	Presentations of the results of student study (research) work as scheduled. Discussion.	26
Se 15	Summary of classes. Grading.	2
...		30
	Total hours	

TEACHING TOOLS USED

N1. Traditional seminar based on multimedia presentations
N2. Students' own work - participation in the implementation of student research papers
N3. Consultations for students

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
P	PEU_U01 PEU_U02 PEU_K01	Grades for the presentation of completed work (scope, coherence, readability, timeliness) and class activity (ability to lead and participate in discussions).

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Literature on the scope of the conducted study research selected by the student for the thesis.
[2] Thesis Writing for Master's and Ph.D Program, Parija, Springer 2018
[3] Rzędowska A., Rzędowski J.: Mistrzowskie prezentacje. Slajdowy poradnik mówcy doskonałego. Wydanie 2, Helion, Giwice 2017.
[4] Requirements for a master's thesis at the Faculty and Technical University of Wroclaw.

SECONDARY LITERATURE:

[1] Kraśniewski A., Techniki Prezentacji, materiały dydaktyczne, http://cygnus.tele.pw.edu.pl/~andrzej/TP/tp_m.htm
[2] Siuda P., Wasylczyk P., Publikacje naukowe. Praktyczny poradnik dla studentów, doktorantów i nie tylko. PWN, Warszawa 2018

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

Dariusz Król dariusz.krol@pwr.edu.pl

Zał. nr 1a do ZW 35/2022

FACULTY OF MANAGEMENT

SUBJECT CARD

Name of subject in Polish Etyka nowych technologii
Name of subject in English Ethics of new technologies
Main field of study (if applicable): Applied Computer Science
Specialization (if applicable): Computer Engineering
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W08IST-SM4017S
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)					60
Form of crediting	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	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)					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)					1,2

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

No prerequisites required.

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SUBJECT OBJECTIVES

C1 Student acquires knowledge on ethical aspects of new and emerging technologies, including dilemmas related to technology assessment;
C4 Student is aware of the importance of ethical rules related to technology development and competent to initiate activities on behalf of the public interest.
C5 Student is aware of non-technical aspects of engineering and of social responsibility of an engineer.

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:

PEU_W01 [P7S_WK1]: Knows and understands the etic and humanistic conditions of undertaking various types of professional activities relating to the awarded qualification.

PEU_W02 [P7_WK3]: Knows and understands the fundamental dilemmas of modern civilization.

Relating do skills:

PEU_U01 [P7S_UK]: Is able to lead debates.

Relating to social competences:

PEU_K01 [P7S_KK]: Is ready to critically evaluate the content he receives.

PEU_K02 [P7S_KO]: Is ready to take action in the public interest.

PROGRAMME CONTENT

	Seminar	**Number of hours**
Semin 1	Introduction: morality, ethics, law. General ethics and applied ethics.	1
Semin 2	Ethical theories and types of justification of moral judgements. Disagreement in knowledge and in attitudes.	2
Semin 3	Ethical dilemma: structure and types. Ethical dilemmas related to engineering and technology assessment.	2
Semin 4	Expert and participatory technology assessment. Technology governance.	2
Semin 5	Risks and benefits of technology use; user experience. Case analyses, roboethics and other examples.	2
Semin 6	Ethical approaches tailored to new technologies. Ethical guidelines.	2
Semin 7	Ethical rules for professional engineering. Selected codes of ethics.	2
Semin 8	Obligations towards society: responsible research and innovation (RRI). Summary of the course.	2
	Total hours	15

TEACHING TOOLS USED

N1. Interactive lecture with multimedial presentation.
N2. Student groupwork.
N3. Student individual work.
N4. Case analysis.
N5. Brainstorming.
N6. Scenario workshop.
N7. Thematic discussion.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01, PEU_W02, PEU_U01, PEU_K01	Written work (case analysis)
F2	PEU_W01, PEU_W02, PEU_U01, PEU_K01, PEU_K02	Participation in discussions and group activities.
P=F1+F2 Weighted average of evaluation F1 (2/3 of concluding mark) and evaluation F2 (1/3 of concluding mark).		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Gwiazdowicz M., Stankiewicz P. *Technology Assessment. Problematyka oceny technologii* „Studia BAS" 2015, 3(43).

[2] Małek M. Mazurek E., Serafin K., *Etyka i technika. Etyczne, społeczne i edukacyjne aspekty działalności inżynierskiej,* Wrocław 2014.

[3] Michalski K., *Technology Assessment – nowe wyzwania dla filozofii nauki i ogólnej metodologii nauk,* Oficyna Wydawnicza Politechniki Rzeszowskiej 2019.

SECONDARY LITERATURE:

[1] Bińczyk E., *Technonauka w społeczeństwie ryzyka,* Wyd. Naukowe UMK 2012.

[2] Chyrowicz B., *O sytuacjach bez wyjścia w etyce,* Wyd. Znak, Kraków 2008.

[3] Małek-Orłowska M., *Niemoralność finansowania robota? O negatywnej rekomendacji AOTM dla robota Da Vinci,* „Prawo i Medycyna" 2016, 1 (62/18), s. 68-80.

[4] Małek-Orłowska M., *Technologie human enhancement: zakres zastosowania i metody oceny,* (red. E.Bińczyk i in.) *Horyzonty konstruktywizmu: inspiracje, perspektywy, przyszłość,* Wyd. UMK 2015.

[5] Stankiewicz P. *Od przekonywania do współdecydowania: zarządzanie konfliktami wokół ryzyka i technologii,* „Studia Socjologiczne" 2011, 4 (203).

[6] Stankiewicz P., *Zbudujemy wam elektrownię (atomową!). Praktyka oceny technologii przy rozwoju energetyki jądrowej w Polsce,* „Studia Socjologiczne" 2014, 1 (212), s. 77-107.

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

Monika Małek-Orłowska, monika.malek@pwr.edu.pl

Zał. nr 6 do ZW 16/2020

FACULTY of Information and Communication Technology

SUBJECT CARD

Name of subject in Polish: Podstawy inżynierii wiedzy
Name of subject in English: Foundations of Knowledge Engineering
Main field of study (if applicable): Applied Computer Science
Specialization (if applicable): Computer Engineering (CE)
Profile: academic
Level and form of studies: 2nd level, , full-time studies
Kind of subject: obligatory
Subject code: W04IST-SM4107G
Group of courses YES / ~~NO~~*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	30			
Number of hours of total student workload (CNPS)	120	90			
Form of crediting	Examination / ~~crediting with grade~~*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark final course with (X)	X				
Number of ECTS points	4	3			
including number of ECTS points for practical (P) classes					
including number of ECTS points for direct teacher-student contact (BK) classes	2,4	1,8			

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of logics, set theory, probability theory, graph theory.

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SUBJECT OBJECTIVES

C1 Acquiring understanding of issues related to using computers in solving engineering problems concerning knowledge.

C2 Developing skills in formulating mathematical models based on available knowledge and/or on collected data, in designing solution algorithms to analysis, diagnostic, and decision making problems, and in application of existing software tools.

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01 Student is able to define a knowledge representation (KR) using relations or logical formulas, and formulate analysis problem (AP), diagnostic problem (DP), and decision making problem (DMP) based on these KRs.

PEU_W02 Student is able to explain specific concepts of knowledge validation and updating devoted to a relational KR and to a logical KR

PEU_W03 Student is able characterize the process of knowledge discovery in databases and define several data mining problems and methods useful in knowledge acquisition.

relating to skills:

PEU_U01 Student is capable of applying knowledge processing algorithms for solving AP, DP and DMP.

PEU_U02 Student is capable of applying knowledge validation and updating algorithms to relational and logical KRs.

PEU_U03 Student knows how to process data so as to discover knowledge, and how to use existing software to carry out this task.

PROGRAM CONTENT

Lectures		**Number of hours**
Lec 1	Introduction. Main problems of knowledge engineering. Classical mathematical models vs. knowledge representations (KRs).	2
Lec 2, Lec 3	Relational KR.	4
Lec 4 – Lec 6	Logical KR. Issues on computational complexity.	6
Lec 7, Lec 8	Probabilistic uncertainty in logical KR – probabilistic reasoning and Bayesian networks.	4
Lec 8 - Lec 10	Validation and updating of a relational knowledge KR.	3
Lec 10, Lec 11	Automated knowledge extraction from large data sets. Knowledge discovery in databases. Attributes' domains discretization and other data mining problems.	2
Lec 11 – Lec 13	Association rules.	4
Lec 13, Lec 14	Decision trees.	3
Lec 15	Data clustering.	2
	Total hours	30

Classes		**Number of hours**
Cl1 – Cl6	Solving example problems of mathematical modeling with the use of knowledge representations, solving analysis, diagnostic and decision making problems based on knowledge representations.	12
Cl7	Test 1	2
Cl8 –	Numerical examples on knowledge validation and updating. Logical KR, Bayesian	6

Cl10	networks, relational KR. Using software tools.	
Cl11, C12	Mining data for association rules - numerical example, computer simulations.	3
Cl12, Cl13	Mining data for decision trees - numerical example, computer simulations.	3
Cl14	Mining data for clusters - numerical example, computer simulations.	2
Cl15	Test	2

TEACHING TOOLS USED

N1. Traditional lecture.
N2. Students' individual work – solving computational exercises.
N3. Students' individual work – programming.
N4. Students' individual work – performing computer simulations.
N5. Students' individual work – studying literature.

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 (lecture)	PEU_W01 – PEU_W03	Examination
F2 (classes)	PEU_U01 – PEU_U03	Observation of students' activity during classes, evaluation of assignments, tests.
C1 (lecture and classes as per GK)	PEU_W01 – PEU_W03, PEU_U01 – PEU_U03	Based on F1 and F2, Both F1> 2 and F2> 2 is required.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1]

SECONDARY LITERATURE:

[1] P. Adrians, D. Zantige “Data mining”, Addison-Wesley, 1996
[2] T. Mitchell “Machine Learning”, McGraw-Hill, 1997
[3] Z. Bubnicki “Modern Control Theory”, Springer Verlag, 2005
[4] N. T. Nguyen “Advanced Methods for Inconsistent Knowledge Management”, Springer Verlag, 2007

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

Donat Orski, donat.orski@pwr.edu.pl

Zał. nr 5 do ZW 16/2020

FACULTY of Information and Communication Technology

SUBJECT CARD

Name of subject in Polish Podstawy biznesu i ochrona własności intelektualnej
Name of subject in English Fundamentals of Business and Intellectual Protection
Main field of study (if applicable): Applied Computer Science
Specialization (if applicable): Computer Engineering
Profile: academic / ~~practical~~*
Level and form of studies: ~~1st/~~ 2nd level, uniform magister studies*, full-time / part-time studies*
Kind of subject: obligatory / ~~optional / university-wide*~~
Subject code: W08IST-SM4018W
Group of courses ~~YES~~ / NO*

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

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

No prerequisites

SUBJECT OBJECTIVES

C1. The aim of the course is to familiarize students with the principles of creating, development and management of an enterprise.
C2. The aim of the course is to familiarize students with the principles of intellectual property management.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 Student understands the essence of the concept of entrepreneurship and enterprise, knows the rules and areas of its operation.
PEU_W02 Has a general knowledge of the process of setting up a company.
PEU_W03 Student knows and understands the basic concepts and regulations concerning the Intellectual property protection.

PEU_W04 Student has general knowledge of available patent information sources and its use in innovation processes.

relating to social competences:
PEU_K01 The student understands the consequences of the activities undertaken as part of business activity.

PROGRAM CONTENT

	Lectures	**Number of hours**
Lec 1	Introduction - an outline of the lecture, credit terms, literature. The company in a market economy.	2
Lec 2	The company's business environment, market intelligence.	2
Lec 3	The formal organization of the company.	2
Lec 4	The strategy creation in the company.	2
Lec 5	Determination of a business model – marketing management.	2
Lec 6	Determination of a business model – finance and logistics management.	2
Lec 7	Brand management.	2
Lec 8	Assesment part I	2
Lec 9	The concept and role of intellectual property protection.	2
Lec 10	Industrial property – patents: protection system (part I).	2
Lec 11	Industrial property – patents: protection system (part II).	2
Lec 12	Industrial property – trade marks: protection system.	2
Lec 13	Industrial property – designs: protection system. Other elements of industrial property: utility models, geographic indications.	2
Lec 14	Copyrights and related rights.	2
Lec 15	Assemesment part II	2
	Total hours	30

TEACHING TOOLS USED

N1. Informative lecture supported by a multimedia presentation
N2. Problem-based lecture supported by a multimedia presentation
N3. Case study

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), C – concluding (at semester end)	Learning outcomes number	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02 PEU_K01	Written test
F2	PEU_W03 PEU_W04	Presentation, written report
C = 0,5*F1 + 0,5*F2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

Kotler P., Keller K.L., Marketing Management, 15th Global ed. Always Learning. Boston; Pearson, 2016

Palfrey J., Intellectual property strategy, Cambridge; MIT Press, London 2012

SECONDARY LITERATURE:

Harvard Business Review

World Intellectual Property Organization www.wipo.int

European Patent Office www.epo.org

Urząd Patentowy Rzeczpospolitej Polskiej www.uprp.pl

Domestic Patent Office

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

Anna Sałamacha, anna.salamacha@pwr.edu.pl

Zał. nr 5 do ZW 16/2020

FACULTY of Information and telecommunication technology

SUBJECT CARD

Name of subject in Polish Praca dyplomowa I
Name of subject in English MSc Thesis (1)
Main field of study (if applicable): Applied Computer Science
Specialization (if applicable): ……..
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W04IST-SM4016P
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)				30	
Number of hours of total student workload (CNPS)				60	
Form of crediting	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / 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)					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				1,2	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Can choose the right research method for the problem task being solved

\

SUBJECT OBJECTIVES

C1 Realization of the literature review and works related to the thesis topic.
C2 Determination of the purpose and scope of the thesis.
C3 Acquire the ability to obtain information, including in English, on relevant issues related to the problems of the thesis topic.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

relating to skills:
PEU_U01 - Is able to find information from various sources, analyze, synthesize and document

it
PEU_U02 - Is able to critically analyze existing solutions and, if necessary, propose their improvements
PEU_U03 - Can plan and implement the process of self-education, identify possible directions for further learning
relating to social competences:
PEU_K01 - is ready to critically evaluate the received content and is aware of the importance of knowledge in problem solving

PROGRAMME CONTENT

	Project	**Number of hours**
Proj 1	Determine the scope of work to be completed in the semester.	2
Proj 2	Literature review and its documentation (can be done iteratively). Refinement of the purpose and scope of the thesis.	26
Proj 3	Discussion of the results obtained. Grading.	2
	Total hours	30

TEACHING TOOLS USED

N1. Students' own work - review of literature and related works.
N2. Examples of theses, including those containing a literature review.
N3. Consultation for students.

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
P	PEU_U01…PEU_U03 PEU_K01	Evaluation of the work performed and the documentation prepared (scope, consistency, legibility, timeliness).

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Current literature directly relevant to the topic being pursued - selected according to the instructor's instructions and found by the student.
[2] Thesis Writing for Master's and Ph.D Program, Parija, Springer 2018.

SECONDARY LITERATURE:

[1] B Kitchenham, S Charters, "Guidelines for performing systematic literature reviews in software engineering", EBSE Technical Report EBSE-2007-01, http://robertfeldt.net/advice/kitchenham_2007_systematic_reviews_report_updated.pdf
[2] Komitet Etyki w Nauce Polskiej Akademii Nauk, Dobre obyczaje w nauce – zbiór zasad i wytycznych. http://www.ken.pan.pl/images/stories/pliki/pdf/down.pdf (6.02.2009)
[3] Siuda P., Wasylczyk P., Publikacje naukowe. Praktyczny poradnik dla studentów, doktorantów i nie tylko. PWN, Warszawa 2018
[4] Maciej Sydor: Wskazówki dla piszących prace dyplomowe. Wydawnictwo Uniwersytetu Przyrodniczego w Poznaniu, Poznań 2014.

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

Dariusz Król dariusz.krol@pwr.edu.pl

Zał. nr 5 do ZW 16/2020

FACULTY of Information and telecommunication technology

SUBJECT CARD

Name of subject in Polish Praca dyplomowa II
Name of subject in English MSc Thesis II
Main field of study (if applicable): Applied Computer Science
Specialization (if applicable): ……..
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W04IST-SM4014D
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)				150	
Number of hours of total student workload (CNPS)				540	
Form of crediting	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points				18	
including number of ECTS points for practical classes (P)				18	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				10,8	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge and competence in applied research methods and tools in the discipline of technical informatics and telecommunication.

\

SUBJECT OBJECTIVES

C1 Implementation and documentation of the research conducted in the thesis.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
relating to skills:
PEU_U01 - Is able to find information from various sources, analyze, synthesize and document it
PEU_U02 - Is able to critically analyze existing solutions and, if necessary, propose their improvements
PEU_U03 - Can plan and implement the process of self-education, identify possible directions for further learning

relating to social competences:
PEU_K01 - Can think and act creatively and entrepreneurially

PROGRAMME CONTENT

	Project	**Number of hours**
Proj 1	Determination of a preliminary work schedule	2
Proj 2	Implementation and documentation of research according to the schedule (can be in stages or iteratively).	146
Proj 3	Summary of the results obtained. Grading.	2
	Total hours	150

TEACHING TOOLS USED

N1. Students' own work - participation in the implementation of student's research work.
N2. Examples of theses, including those containing original results of a cognitive nature.
N3. Consultation for students.

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
P	PEU_U01…PEU_U03 PEU_K01	Evaluation of completed research and its documentation (scope, consistency, readability, cleanliness of language timeliness, originality of research/improvements).

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Current literature directly relevant to the topic being pursued.
[2] Thesis Writing for Master's and Ph.D Program, Parija, Springer 2018.

SECONDARY LITERATURE:

[1] Requirements for a master's thesis at the Faculty and Technical University of Wroclaw.
[2] Maciej Sydor: Wskazówki dla piszących prace dyplomowe. Wydawnictwo Uniwersytetu Przyrodniczego w Poznaniu, Poznań 2014.
[3] Siuda P., Wasylczyk P., Publikacje naukowe. Praktyczny poradnik dla studentów, doktorantów i nie tylko. PWN, Warszawa 2018.
[4] Komitet Etyki w Nauce Polskiej Akademii Nauk, Dobre obyczaje w nauce – zbiór zasad i wytycznych. http://www.ken.pan.pl/images/stories/pliki/pdf/down.pdf (6.02.2009).

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

Dariusz Król dariusz.krol@pwr.edu.pl

FACULTY of Information and Communication Technology

SUBJECT CARD

Name of subject in Polish: **Modelowanie i analiza systemów informatycznych**
Name of subject in English: **Information Systems Modelling and Analysis**
The main field of study (if applicable): **Applied Computer Science**
Specialization (if applicable): **Computer Engineering**
Profile: **academic**
Level and form of studies: **2nd level, full-time studies**
Kind of subject: **obligatory**
Subject code: **W04IST-SM4004G**
Group of courses: **YES**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	30			
Number of hours of total student workload (CNPS)	120	90			
Form of crediting	Examination	crediting with grade	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For a group of courses mark the final course with (X)	X				
Number of ECTS points	4	3			
including number of ECTS points for practical (P) classes	0	0			
including number of ECTS points for direct teacher-student contact (BU) classes	2,4	1,8			

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS, AND OTHER COMPETENCIES

1. Experience in object-oriented programming.
2. Basic knowledge of software engineering.

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SUBJECT OBJECTIVES

C1 Basic knowledge of modeling in the context of object-oriented processes of information systems development.
C2 Modern modeling languages: the Unified Modeling Language, Business Process Modeling Notation, and SysML as standards in modern approaches to information systems modeling.

SUBJECT LEARNING OUTCOMES

relating to knowledge:
PEU_W01 Students have detailed knowledge of modeling and analysis of information systems. Especially, they know and understand the role of business modeling and

specification of system requirements.

relating to skills:

PEU_U01 Students are able to model processes occurring during the development of an information system, in particular, are able to develop business models and models of system requirements

PEU_U2 Students are able to identify and describe business processes related to information systems development, know how to use tools for the analysis of these processes.

PROGRAM CONTENT

	Lectures	**Number of hours**
Lec 1	Software development cycle; basic paradigms in software development.	2
Lec 2	Introduction to UML; introduction to UML class and object diagrams.	2
Lec 3	Binary associations; aggregations and compositions.	2
Lec 4	n-ary associations; association classes.	2
Lec 5	Generalization relationships, properties of generalization sets, generalization definition by extensions and restrictions; redefinitions in the context of generalizations.	2
Lec 6	Dependency relationships; development of class diagrams in domain modeling.	2
Lec 7	Introduction to behavior presentation; simple UML state diagrams.	2
Lec 8	Advanced UML state diagrams.	2
Lec 9	Simple BPMN process diagrams.	2
Lec 10	Advanced BPMN process and collaboration diagrams.	2
Lec 11	Introduction to requirement specification; functional and non-functional requirements; UML use case diagram; elements of UML sequence diagrams.	2
Lec 12	Specification of quality demands; SysML requirements diagrams.	2
Lec 13	Object Constraint Language.	2
Lec 14	UML implementation diagrams – component and deployment diagrams.	2
Lec 15	Metamodeling, UML metamodel.	2
	Total hours	30

	Form of classes – class	**Number of hours**
Cl 1	Short review of the basic concepts of set theory.	2
Cl 2	Construction and analysis of simple class diagrams.	2
Cl 3	Object diagrams as instances of class diagrams.	2
Cl 4	Analysis of advanced elements of class diagrams (association classes, n-ary associations).	2

Cl 5	Case study – an example of structural modeling.	2
Cl 6	Construction and analysis of OCL constraints imposed on class diagrams.	2
Cl 7	Intermediate test.	2
Cl 8	Construction and analysis of use case diagrams.	2
Cl 9	Interpretation of use cases using sequence diagrams.	2
Cl 10	Interpretation of use cases using activity diagrams.	2
Cl 11	Construction and analysis of simple BPMN diagrams.	2
Cl 12	Construction and analysis of advanced BPMN diagrams.	2
Cl 12	Construction and analysis of simple state diagrams.	2
Cl 13	Construction and analysis of advanced state diagrams.	2
Cl 14	SysML requirements diagrams.	2
Cl 15	Final test.	2
	Total hours	30

TEACHING TOOLS USED

N1. Lecturer's presentation on a blackboard, supported by a multimedia presentation using a laptop and a projector.
N2. Individual search and study of literature and Internet sources.
N3. Access to teaching materials published in the university ePortal.
N4. Individual consultations.

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_U01 PEU_U02	Each student receives 1 point for a presentation of independently solving a problem from the list of tasks for a given class.
F2	PEU_W01 PEU_U01 PEU_U02	Each student receives up to 10 points for independently solving problems for the given test intermediate and final).
F3	PEU_W01 PEU_U01 PEU_U02	Each student receives up to 15 points for independently solving problems for the examination test.

The grade for classes is based on the score obtained from the sum of F1 and F2 according to the table:

Points	10	12	14	16	18
Grade	3.0	3.5	4.0	4.5	5.0

Grade 3.0 for classes is a necessary condition to pass the course.
If the grade for classes is at least 4, the student is exempted from the examination test and receives the same grade for the entire course.

The final grade for the subject is based on the sum of points received within evaluations F1, F2, and F3, according to the table:

Points	15	16	20	25	30
Grade	3.0	3.5	4.0	4.5	5.0

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Sommerville I., *Software Engineering*, Pearson Education Limited, 2016.
[2] Krogstie J. Model-Based Development and Evolution of Information Systems, Springer-Verlag London 2012.
[3] Olivé A., Conceptual Modeling of Information Systems, Springer-Verlag Berlin Heidelberg 2007.
[4] Rumbaugh J., Jacobson I., Booch G., *The Unified Modeling Language – Reference Manual*. Second edition, Addison-Wesley, 2005.

SECONDARY LITERATURE:

[4] Object Management Group, Unified Modeling Language (available on the website: www.omg.com).
[5] Object Management Group, Business Process Modeling Notation BPMN (available on the website: www.omg.com).
[6] Object Management Group, System Modeling Language SysML (available on the website: www.omg.com).
[7] Weilkiens T., Oestereich B., *UML 2 Certification Guide. Fundamental and Intermediate Exams*, Elsevier 2007.

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

Zbigniew Huzar, zbigniew.huzar@pwr.edu.pl

FACULTY of Information and Communication Technology

SUBJECT CARD

Name of subject in Polish: Metody planowania i analizy eksperymentów
Name of subject in English: Methods of planning and analyzing experiments
Main field of study (if applicable): Applied Computer Science
Specialization (if applicable): Computer Engineering
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W04IST-SM4020G
Group of courses: YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15				
Number of hours of total student workload (CNPS)	30				
Form of crediting	crediting with grade				
For group of courses mark (X) final course					
Number of ECTS points	1				
including number of ECTS points for practical classes (P)					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0.6				

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge and skills in mathematical analysis and algebra in the field of engineering programs.
2. Knowledge of basic concepts of probability in the field of engineering programs.

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SUBJECT OBJECTIVES

C1 Presentation of the main principles related to the design of a statistical experiment.
C2 Transfer of knowledge on choosing appropriate descriptive analysis tools and statistical tests in order to analyze the experimental data.
C3 Transfer of knowledge on building and correct interpretation of basic statistical models.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 knowledge of basic principles concerning design of a statistical experiment,
PEU_W02 knowledge of descriptive data analysis tools,
PEU_W03 knowledge of basic statistical tests and their specific assumptions,
PEU_W04 basic knowledge on statistical analysis of the relationship between quantitative variables and linear regression models.

relating to skills:
PEU_U01 ability to choose and compute appropriate basic descriptive statistics for experimental data,

PEU_U02 ability to use graphical methods of data presentation and interpretation of the results obtained,
PEU_U03 ability to choose appropriate statistical tests to analyze experimental data,
PEU_U04 ability to perform statistical analysis of correlation and to build and interpret linear regression models.

relating to social competences:
PEU_K01 ability to use scientific literature, including accessing and reviewing source materials,
PEU_K02 understanding the need for systematic and independent work on mastering the course material.

PROGRAMME CONTENT		
Lecture		**Number of hours**
Lec 1	Elementary concepts of statistics. Population and sample. Types of statistical variables. Basic principles of experimental design.	2
Lec 2	Descriptive data analysis. Graphical presentation of data. Basic summary statistics and their properties.	2
Lec 3	Data preparation for statistical analysis (subset selection, standardization, discretization, simple transformations). Data quality problem: missing and unusual observations.	1
Lec 4	Theoretical foundations of statistical methods. Elements of probability theory. The most important discrete and continuous random variables and their distributions. Estimation of parameters. Fitting appropriate distribution to data. Confidence intervals. Determination of the sample size.	2
Lec 5	Introduction to statistical hypothesis testing. The main concepts: null and alternative hypothesis, statistical significance. General procedure used to verify a statistical hypothesis. Type I and type II errors. Power of a statistical test. One-sided and two-sided tests. Types of statistical tests (tests of significance, goodness-of-fit and independence tests). Relationship between hypothesis testing and confidence intervals.	2
Lec 6	Basic parametric tests for one and two populations. Tests of significance for mean and variance. Significance test for a proportion. Selected goodness-of-fit tests (chi-square test, test for normality).	2
Lec 7	Investigating the relationship between two quantitative variables: correlation coefficient and scatter plot. Statistical test for significance of correlation. Analysis of multiple correlation (correlation matrix). Nonlinear relationships between variables. Typical mistakes concerned with examining relationships between variables.	1
Lec 8	Linear regression model. Simple linear regression: model assumptions and interpretation. Model fitting and diagnostics. Choosing the best model. Multiple regression. Variable selection in regression. Using fitted regression model for prediction. Limitations of linear regression models.	2

Lec 9	Final test.	1
	Total hours	15

TEACHING TOOLS USED
N1. Lecture – traditional method. N2. Consultations. N3. The unassisted student work: homework, preparation for the test.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01-PEU_W04 PEU_U01-PEU_U04 PEU_K01-PEU_K02	Final test
F2	PEU_U01-PEU_U04 PEU_K01-PEU_K02	Homework
P – A student who has earned at least 50% of all possible points (obtained both from the final test and homework assignments) can receive a positive mark. However, the maximum number of homework points earned by a student cannot exceed 15% of the total number of points possible from the final test.		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[8] J. Koronacki, J. Mielniczuk, Statystyka dla studentów kierunków technicznych i przyrodniczych, WNT, Warszawa 2004.

[9] A. D. Aczel, Statystyka w zarządzaniu, PWN, Warszawa 2007.

[10] L. Gajek, M. Kałuszka, Wnioskowanie statystyczne. Modele i metody, WNT, Warszawa 2004.

[11] W. Klonecki, Statystyka dla inżynierów, PWN, Warszawa 1999.

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

SECONDARY LITERATURE:

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

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

[3] H. Kaasyk-Rokicka, Statystyka. Zbiór zadań. PWE, Warszawa 2011.

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

Wrocławskiej, Wrocław 1984.
[5] M. Sobczyk, Statystyka. PWN, Warszawa 2007.
[6] K. Black, Business Statistics: For Contemporary Decision Making, Wiley, 5th edition, 2007.

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

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Zał. nr 5 do ZW 16/2020

Faculty of Information and Communication Technology

SUBJECT CARD

Name of subject in Polish: Multimedialne systemy mobilne
Name of subject in English: Mobile and multimedia systems
Main field of study (if applicable): Applied Computer Science
Specialization (if applicable): Computer Engineering
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W04IST-SM4007G
Group of courses: YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	90		90		
Form of crediting	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark final course with (X)					
Number of ECTS points	3		3		
including number of ECTS points for practical (P) classes			3		
including number of ECTS points for direct teacher-student contact (BK) classes	1.8		1.8		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Fundamentals of programming in ANDROID or APPLE iOS environment.
2. Fundamentals of mobile application interface design.
3. The basics of using Autodesk 3ds MAX or BLENDER.

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SUBJECT OBJECTIVES

C1. Acquire the ability to design and program multimedia mobile systems using a variety of authoring environments.
C2. Acquire the ability to evaluate the time and cost of building a multimedia mobile system.
C3. Master the basics of marketing and operating mobile multimedia systems.

SUBJECT LEARNING OUTCOMES

In terms of knowledge:

PEU_W01 Knows and understands the characteristics of mobile multimedia applications.

PEU_W02 Has knowledge of the design and programming of mobile multimedia applications.

From the scope of skills:

PEU_U01 Can define a set of potential functional requirements of a mobile multimedia application, can collaborate with a potential user of a mobile multimedia application to define these requirements.

PEU_U02 Is able to design a mobile multimedia application taking into account the functional requirements and specifics of the potential users

PEU_U03 Can program a mobile multimedia application.

In terms of social competence:

PROGRAM CONTENT

	Lectures	**Number of hours**
Lec 1	Organizational lecture. Presentation of the lecture idea. Basic concepts and definitions.	2
Lec2	Compression of media data. Compression formats used in mobile systems. Codecs. Surround sound systems - implementation in mobile devices.	2
Lec 3	Sources of multimedia acquisition. Internet multimedia collections. Commercial collections of multimedia elements. Recording studios, film studios, multimedia studios, graphic design studios.	2
Lec 4	How to reconcile design and functionality of mobile application interface ? Designing interface prototypes (mockap). Overview of programs for constructing interface prototypes.	2
Les 5	Mobile application interfaces. Interactive product presentation. Guidelines for constructing interfaces. Non-verbal guidelines. Recommendations - Material Design (Android) and Human User Interface (Apple)	2
Les 6 Les 7	Basics of 2D and 3D computer animation. Discussion of basic animation mechanisms. Timeline. Modeling, texturing, setting up lights, camera selection, rendering, publishing animation. Interactive photorealistic visualization.	4
Lec 8 Lec 9	Kompletna, szczegółowa relacja z projektowania i programowania mobilnej, multimedialnej aplikacji kategorii m-commers z elementami interaktywnej wizualizacji 3d produktu.	4

Lec 10 Lec 11	Overview of libraries supporting mobile application programming on Android and Apple iOS platforms. Native programming in Kotlin (Android) and SWIFT UI (Apple) environments. Frameworks - overview and constructive analysis and comparison.	4
Lec 12	Mobile games. UNITY. Game engine. Constructing worlds, programming character behavior, setting up lights and camera, simulating physical phenomena, sound and its integration into the game action. Overview of popular games for mobile devices.	2
Lec 13	Review of selected multimedia applications. Modern TV - a high-speed graphics station, with its own operating system. Soundbar - a specialized sound processor. Built-in cameras in smartphones. 3D printers. Drones, as a transporter of specialized cameras.	2
Lec 14	Augmented reality (augmented reality). Generation of virtual objects. Application in m-commerce applications for photorealistic presentation of objects, in education, in tourism. Discussion of the stages of designing and programming a mobile application with augmented reality elements.	2
Lec 15	Directions of development of computer multimedia techniques. Summary.	2
	Total hours.	30

Laboratory		**Number of hours**
Lab 1	Organizational laboratory. Presentation of the idea of laboratory classes. Leading topic - complete application of m-commers.	2
Lab 2	Discussion of the type of products sold and how they are presented on the screen of a mobile device. Discussion of the problem of responsiveness. Design of the interface prototype (mockup). Design of the mechanism for interactive multimedia presentation of the product. Discussion of the project implementation schedule.	2
Lab 3	LAB TASK 1	2

	Design and implementation of the m-commerce application interface in Adobe XD, FIGMA or other environment that allows for mockup design.	
Lab 4	LAB TASK 2 Basics of using Autodesk 3ds MAX or BLENDER environment. Scene design, creating simple 3d models and embedding them in the scene.	2
Lab 5 Lab 6	LAB TASK 3 Modeling of the interior (scene) in which the objects will be presented. Modeling of objects. Camera selection. Animation of the camera along the set trajectory..	4
Lab 7 Lab 8	LAB TASK 4 Texturing of objects and scene. Selecting the type of lights. Rendering of a static scene.	4
Lab 9 Lab 10	LAB TASK 5 Prepare a storyboard and animation parameters (number of frames per second, animation length expressed in frames, resolution). Exporting the animation as a collection of files.	4
Lab 11 Lab 12	LAB TASK 6 Design of a mobile application that manages animation prepared in 3ds MAX environment in KOTLIN or SWIFT language. Implementation of interaction mechanisms.	4
Lab 13 Lab 14	LAB TASK 7 Adding interaction to selected objects - e.g. object rotation, color change, door opening, etc. Adding sound and ZOOM effect.	4
Lab 15	Showcase of project	2
	Total hours	30

TEACHING TOOLS USED
N1. Multimedia presentations. N2. The practical introduction to the use of the software developer.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F –	Learning	Way of evaluating learning outcomes achievement

forming (during semester), P – concluding (at semester end)	outcomes number	
F1 - Lecture	PEU_W01, PEU_W02	An essay on the indicated topic (max 10 points)
F2 - Project	PEU_U01, PEU_U02, PEU_U03	The final grade of the lab F2 is determined as follows: A certain number of points can be earned for a correctly completed laboratory task: LAB TASK 1 – 2 score LAB TASK 2 – 2 score LAB TASK 3 – 3 score LAB TASK 1 – 3 score LAB TASK 1 – 4 score LAB TASK 1 – 4 score LAB TASK 1 - 4 score
F3 - Lecture	PEU_W01 PEU_W02	Test (max 12 points) – a student must obtain at least 50% of points to pass the test

P – concluding evaluation of the subject is equal to:

$$P = 0,4 * (F1 + F3) + F2 * 0,6$$

The final evaluation of the subject depends on the resulting P value and is:

20 – 22	excellent (5,5)
16 – 19	very good (5,0)
14 – 15	good plus (4,5)
12 – 13	good (4,0)
10 – 11	satisfactory plus (3,5)
8 – 9	satisfactory (3,0)
< 8	insufficient (2,0)

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Unity 2018 Game Development in 24 Hours, Mike Geig, Person Education, 2018
[2] Designing Interfaces: Patterns for Effective Interaction Design, Jenifer Tidwell, Charlie Brewer, AynneValencia,
[3] Augmented Reality with Unity AR Foudation (ebook), Jonathan Linowe, Pact Publishing, 2021
[4] SwiftUI Cookbook – Second Edition (ebook), Giordano Scalzo, Edgar Nzokwe, Pact Publishing, 2020.

[5] Android UI Development with Jet[ack Compose (ebook), Thomas Kunneth, Pact Publishing, 2020.
[6] Autodesk 3ds Max 2022: A Comprehensive Guide, 22nd Edition, Prof. Sham Tickoo Purdue Univ, CADCIM Technologies, 2021

SECONDARY LITERATURE:

[1] ⌈Jakob Nielsen, Raluca Budiu: Funkcjonalność aplikacji mobilnych. Nowoczesne standardy UX i UI (tyt. org.: Mobile Usability; tł. Marta Najman), Helion, 2013
[2] Jason Tyler, Will Verduzco : Hakowanie Androida : kompletny przewodnik XDA Developers po rootowaniu, ROM-ach i kompozycjach (tyt. oryg.:XDA Developers' Android Hacker's Toolkit : the complete guide to rooting, ROMs and theming; tł. Tomasz Walczak) , Helion, 2013
[3] API Guides for Android Developers, http://developer.android.com/ [odczyt z dn.: 2017.07.01]

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

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*delete if not necessary

Zał. nr 5 do ZW 16/2020

FACULTY of Information and Communication Technology

SUBJECT CARD

Name of subject in Polish: Przetwarzanie Równoległe i Rozproszone
Name of subject in English: Parallel and Distributed Computing
Main field of study (if applicable): Applied Computer Science
Specialization (if applicable): Computer Engineering
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W04IST-SM4006G
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	60	60		
Form of crediting	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark final course with (X)	X				
Number of ECTS points	2	2	2		
including number of ECTS points for practical (P) classes			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,2	1,2	1,2		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of computer organization and architecture
2. Programming skills at the intermediate level

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SUBJECT OBJECTIVES

C1 Acquaint students with various environments of parallel processing
C2 Acquaint students with basic parallel algorithms
C3 Acquaint students with various techniques used in the parallelization of programs.
C4 Acquaint students with various architectures of parallel computers.
C5 Acquiring the ability to match the architecture of the computer used to the problem being solved.
C6 Acquisition of parallel programming skills in various environments.
C7 Acquiring the ability to solve various problems related to parallel and distributed

computing.
C8 Acquiring the ability to apply the principles of health and safety at work.
C9 Acquiring the ability to solve complex engineering tasks with the use of techniques used in parallel processing.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 Knows various parallel processing environments.
PEU_W02 Knows basic parallel algorithms.
PEU_W03 Knows various techniques of parallelization of programs.
PEU_W04 Knows various architectures of parallel computers.
relating to skills:
PEU_U01 Can write programs for various parallel environments.
PEU_U02 Is able to solve various problems in parallel and distributed computing.
PEU_U03 Can solve complex engineering tasks using techniques used in parallel processing.

PROGRAM CONTENT

	Lectures	**Number of hours**
Lec 1	Parallel and distributed processing - basic definitions. Parallel computing taxonomy. Static and dynamic connection networks, typical topologies. Declarative and example-based programming.	2
Lec 2	Distributed processing in neural networks, basic architectures of neural networks, applications of neural networks	2
Lec 3	Distributed processing in neural networks, basic architectures of neural networks, applications of neural networks	2
Lec 4	Dynamic architectures of neural networks. Contextual neural networks, measures of internal network activity	2
Lec 5	Deep and convolutional neural networks, applications of convolutional networks	2
Lec 6	Graphics card (GPU) architectures. Programming in the CUDA environment.	2
Lec 7	Hardware and software environments for simulating deep artificial neural networks (including DIGITS, H2O)	2
Lec 8	Distributed and parallel processing in contextual convolutional contextual neural networks	2
Lec 9	MPI standard. Message-passing communication. Group communication.	2
Lec 10	Parallel systems evaluation: performance measures, scalability of parallel systems, Amdhal's, Gustafson's law and others. Performance evaluation by granularity analysis.	2
Lec 11	Parallelization techniques (parallelization, vectorization). Data and algorithmic parallelism.	2
Lec 12	Parallel algorithms for matrix multiplication and sorting.	2
Lec 13	Techniques of loop parallelization.	2
Lec 14	Task allocation to processors, load balancing, scheduling tasks in parallel	2

	environments.	
Lec 15	Parallel and distributed computing environments: with shared and distributed memory (with message passing). Client-server architecture.	2
	Total hours	30

Classes		Number of hours
Cl 1	Solving simple problems in the selection of architectures of artificial neural networks.	1
Cl 2	Assessment of various techniques of signal aggregation in neural networks.	2
Cl 3	Assessment of various techniques of limiting the activity of the internal neural networks.	2
Cl 4	Assessment of various methods of dynamic attribute selection in contextual neural networks.	2
Cl 5	Getting to know the exercise program and the assessment method. Solving simple problems in parallel processing I.	2
Cl 6	Solving simple problems in parallel processing II.	2
Cl 7	Scalability analysis. Use of Amdhal's law for performance prediction.	2
Cl 8	Detecting dependencies in sequential programs and removing them.	2
	Total hours	15

Laboratory		Number of hours
Lab 1	Getting acquainted with the laboratory program, the method of evaluation of exercises, health and safety training. Getting acquainted with the H2O environment used in the laboratory	1
Lab 2	Implementation of the selected contextual neural network in the H2O environment	2
Lab 3	Construction of basic neural networks in H2O and DIGITS environments in the GPU graphics card environment.	2
Lab 4	Implementation of the selected contextual convolutional neural network in the DIGITS environment in the GPU graphics card environment.	2
Lab 5	Comparison of the properties of contextual and context-free neural networks.	2
Lab 6	Getting acquainted with the runtime environment for the MPI standard used in the laboratory.	2
Lab 7	Implementation of a simple algorithm using the "Point to Point" communication in the MPI environment.	2
Lab 8	Implementation of the selected parallel algorithm in the MPI environment.	2
	Total hours	15

TEACHING TOOLS USED

N1. Presentations with projectors

N2. E-learning system used for the publication of teaching materials

N3. On-line lectures, if needed N4. Presentation of solutions to the tasks at the blackboard N5. Computer environment with MPI and H2O software

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), C – concluding (at semester end)	Learning outcomes number	Way of evaluating learning outcomes achievement
F1 Lecture	PEU_W01 PEU_W02 PEU_W03 PEU_W04	Quizzes during the lecture, students' activity during the lecture, students' answers to questions during the lecture, Test (student can receive 30 point max)
F2 Laboratory	PEU_U01 PEU_U02 PEU_U03	Control of students' preparation for the exercise, assessment of exercise reports (point assessment). Assessment of the quality of solutions presented by students. Student can receive 20 point max.
F3 Classes	PEU_U02 PEU_U03	Quizzes during classes, student activity during classes, assessment of tasks solved by students at the blackboard (point assessment). Student can receive 10 point max.
P (final grade)		The final grade will be issued on the basis of the results of the test (F1) and grades of laboratory (F2) and exercises (F3) - point assessment, as follows P = 50% * F1 + 25% * F2 + 25%*F3 The student to pass the course should obtain more than 50% of all possible points (31 points or more). An additional condition for receiving a positive evaluation is obtaining at least 40% of points from each of the components. Number of points: grade 0 - 30: 2.0 31-40: 3.0 41-45: 3.5 46-50: 4.0 51-55: 4.5 56-60: 5.0

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] V. Kumar i inni, "Introduction to Parallel Computing", The Benjamin/Cummings Pub., New York 2003.
[2] J.M. Crichlow, „An introduction to distributed and parallel computing", Prentice Hall, London 1997
[3] Foster I., "Designing and Building Parallel Program (http://www. mcs.aul.gov/dbpp/text/book.html)
[4] B. Wilkinson, M. Allen, "Parallel Programming, Prentice Hall, 2005
[5] Writing Message-Passing Parallel Programs with MPI, Course Notes, (http://www.zib.de/zibdoc/mpikurs/mpi-course.pdf)
[6] Peter Pacheco, Parallel Programming with MPI, Morgan Kaufmann Pub. (http://www.cs.usfca.edu/~peter/ppmpi/)
[7] L.V. Fausett, Fundamentals of Neural Networks: Architectures, Algorithms And Applications, Prentice-Hall, Englewood Cliffs, NJ, 1994
[8] J. Heaton, Artificial Intelligence for Humans, Volume 3: Deep Learning and Neural Networks, Heaton Research Inc., 2015
[9] D. Graupe, Deep Learning Neural Networks: Design and Case Studies, World Scientific Publishing, 2016
[10] CUDA documentation

SECONDARY LITERATURE:

[1] D. Patterson, J. Hennessy, "Computer Architecture – a Quantitave Approach", Elsevier
[2] A.Y.H. Zomaya, „Parallel and distributed computing handbook", McGraw-Hill, New York 1996
[3] M.T. Hagan, H.B. Demuth, M.H. Beale, O. De Jesús, Neural Network Design, Martin. Hagan Publisher, 2014

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Maciej Huk, maciej.huk@pwr.edu.pl

*delete if not necessary

Zał. nr 5 do ZW 16/2020

FACULTY of Information and Communication Technology

SUBJECT CARD

Name of subject in Polish: Fizyczne podstawy współczesnej informatyki

Name of subject in English: Physics of Contemporary Computer Science

Main field of study (if applicable): Applied Computer Science

Specialization (if applicable): Computer Engineering

Profile: academic

Level and form of studies: 2nd level, full-time

Kind of subject: obligatory

Subject code: W04IST-SM4015G

Group of courses: YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15				
Number of hours of total student workload (CNPS)	30				
Form of crediting	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark final course with (X)	X				
Number of ECTS points	1				
including number of ECTS points for practical (P) classes					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,6				

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. None

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SUBJECT OBJECTIVES

C1 Educating the abilities of understanding the principles of physics of Computer Science.

C2 Educating the competences in the scope of understanding physical nature of information and thermodynamics of information media.

C3 Acquiring the knowledge of physics of the telecommunication media, principles of physics of storages, and physical nature of computing machines.

C4 Providing knowledge of contemporary trends in the scope of new data security solutions, algebraic and quantum cryptography and security with use group, field and character theory.

C5 Providing the knowledge of the nature of quantum information.

C6 Acquiring the knowledge of physical nature of bioinformatics.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Student has a knowledge about of physical principles of contemporary computer science.

PEU_W02 Student has a knowledge about the physical nature of information and thermodynamics of informational media.

PEU_W03 Student knows physical phenomena used for creating storage devices.

PEU_W04 Student has knowledge of quantum information and quantum information processing.

PEU_W05 Student has a knowledge of classical and quantum gates, quantum computers, and physical principles of bioinformatics.

relating to skills:

relating to social competences:

PROGRAM CONTENT

	Lectures	**Number of hours**
Lec 1	Introduction. Great discoveries in physics and mathematics leading to originate of computer science.	2
Lec 2	Physical nature of information. Thermodynamics of informational media. Physics and computer software.	2
Lec 3	Physics of telecommunication media.	2
Lec 4	Physical nature of data storages. Materials for creating data storages. Ferromagnetics, ferroelectrics and ferroelstics. Physics of computing machines, bases.	2
Lec 5	Quantum physics and quantum information.	2
Lec 6	Classical and quantum gates. Quantum computers.	2
Lec 7	Final test.	1
Lec 8	Biophysics and bioinformatics.	2
	Total hours	15

TEACHING TOOLS USED

N1. Multimedia presentations
N2. The course Web page
N3. Electronics and paper books and library references

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), C – concluding (at semester end)	Learning outcomes number	Way of evaluating learning outcomes achievement

F1	PEU_W01-PEU_W05	Short tests, final test
C = F1		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Aaronson S.: Quantum computing since Democritus.Cambridge University Press 2013.
[2]. Feynmann R.: The Feynman Lectures on Physics. Basic Books; Slp edition. 2011.
[3] Pardalos P.M., Principe J.C.: Biocomputing. Springer 2002.

SECONDARY LITERATURE:

[1] Rohrkemper R.: Effective Topologies for Computation in Cortex-like Networks: Tools for evaluating computational richness and robustness/ LAP LAMBERT Academic Publishing 2012.
[2] Yanofsky N.S.: Quantum Computing for Computer Scientists. Cambridge University Press 2008.
[3] Stakhov A.: Mathematics of Harmony: From Euclid to Contemporary Mathematics and Computer Science. World Scientific Publishing 2009.
[4] Selected science papers.
[5] ACM Self Assessment Procedure XXII: Ethics, CACM, vol 33, no 11, November 1990.
[6] Kock K.: A Case of Academic Plagiarism. Comm of the ACM, vol 42, no 7, July 1999.
[7] Simon H.: Understanding the natural and the artificial worlds, The Sciences of the Artificial, pp 3-29, 3rd printing, 1984.
[8] Smith A.J.: The task of the Referee, IEEE Computer, vol 23, no 4, April 1990
More reading material will be added during the course.
[9] Sandewall E.: *The Methodology of Design Iteration for Systems-oriented Research in Computer Science. http://www.ida.liu.se/ext/caisor/pm-archive/morador/001/index.html*
[10] Selected scientific papers

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Zał. nr 5 do ZW 16/2020

FACULTY of Information and Communication Technology
DEPARTMENT of Applied Informatics

SUBJECT CARD

Name of subject in Polish: Zarządzanie projektem
Name of subject in English: Project Management
Main field of study (if applicable): Applied Computer Science
Specialization (if applicable): Computer Engineering
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W04IST-SM4021G
Group of courses: YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30			30	
Number of hours of total student workload (CNPS)	90			90	
Form of crediting	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course	X				
Number of ECTS points	3			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)	1,8			1,8	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Completing courses in data base and/or information system design
2. Completing courses in programming web and/or mobile systems

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SUBJECT OBJECTIVES

C1 Familiarize students with modern methods for software project management.
C2 Acquiring knowledge of risk management and project quality assurance.
C3 Acquiring knowledge of team management and communication in IT projects.
C4 Gaining skills in work breakdown, planning, scheduling, cost estimation, and monitoring in IT projects.
C5 Gaining skills in utilizing software tools supporting IT project management.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 student knows and understands the basic processes of an IT project life cycle
PEU_W02 student has a systematised knowledge concerning methods for software project management.
PEU_W02 student knows and understands the notions of risk and quality in IT project.
PEU_W03 student has a well-ordered and theoretically supported knowledge concerning team management and communication in IT project.

relating to skills:
PEU_U01 student can select and apply management methods appropriate for different phases of information system development.
PEU_U02 student is able to carry out work breakdown, allocate resources, workout schedule, estimate costs, monitor and report IT project accomplishment.
PEU_U03 student is able to select software supporting tools for software project management.
PEU_U04 student is able to manage a team accomplishing IT project

Relating to social competences
PEU_K01 student is ready to play a role in IT project management

PROGRAMME CONTENT

Lectures		**Number of hours**
Lec 1	Introduction. Basic notions. Methodologies for IT project management	2
Lec 2	Feasibility study	2
Lec 3	Requirement management	2
Lec 4	Project planning and scheduling	2
Lec 5	IT project control and monitoring	2
Lec 6	Risk management in IT project	2
Lec 7	Project size estimation	2
Lec 8	Project cost estimation	2
Lec 9	Project quality management	2
Lec 10	Project team management	2
Lec 11	Communication in project team	2
Lec 12	Soft skills of project team members	2
Lec 13	IT service management	2
Lec 14	Psychophysiological methods of user experience (UX) research	2
Lec 15	Final test	2
	Total hours	30

Project		**Number of hours**
Proj 1	Introduction. Division into project teams. Selecting IT projects to be managed.	2

Proj 2-3	Working out feasibility study.	4
Proj 4-5	Working out requirement specification.	4
Proj 6	Working out Work Breakdown Structure .	2
Proj 7	Planning and scheduling: Gantt and PERT chart construction.	2
Proj 8	Workload optimization.	2
Proj 9	Project duration shortening.	2
Proj 10-13	Project monitoring: earned value method. Project accomplishment simulation.	8
Proj 14	Project reporting, assessment of techniques used and supporting software.	2
Proj 15	Working out final report.	2
	Total hours	30

TEACHING TOOLS USED

N1. Lecture (delivered with slides)
N2. Project (using supporting software tools)
N3. Consultations
N4. Student's own work

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
P1 - lecture	PEU_W01, PEU_W02, PEU_W03	Final test
F1 -project	PEU_U01, PEU_U02, PEU_U03, PEU_U04	Assessment of tasks accomplished during project and interim reports
P2 -project	PEU_U01, PEU_U02, PEU_U03, PEU_U04	Presentation of completed project and final report
P – the final evaluation shall take into account the test result and the project evaluation		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Project Management Institute. A Guide to the Project Management Body of Knowledge (PMBOK Guide) – 6th Edition 2017 and 7th Edition 2021
[2] Kathy Schwalbe: Information Technology Project Management, 9th Edition. Cengage Learning 2018
[3] Sommerville Ian: Software Engineering (10th Edition). Pearson India 2018
[4] Roger Pressman, Bruce Maxim: Software Engineering: A Practitioner's Approach. McGraw-Hill (9th Edition) 2019

SECONDARY LITERATURE:

[1] Cindy Lewis, Carl Chatfield, Timothy Johnson: Microsoft Project 2019 Step by Step. Microsoft Press (1st edition) 2019
[2] Srikanth Shirodkar: Learning Microsoft Project 2019. Packt Publishing 2020
[3] P. Bourque and R.E. Fairley, eds., Guide to the Software Engineering Body of Knowledge, Version 3.0, IEEE Computer Society, 2014; www.swebok.org
[4] Joseph Phillips: Project Management with CompTIA Project+: On Track from Start to Finish, McGraw Hill (4th Edition) 2017

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Zał. nr 5 do ZW 16/2020

FACULTY of INFORMATION and COMMUNICATION TECHNOLOGY

SUBJECT CARD

Name of subject in Polish: Najnowsze Osiągnięcia w Informatyce
Name of subject in English: Recent Advances in Computer Science
Main field of study (if applicable): Applied Computer Science
Specialization (if applicable): Computer Engineering
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W04IST-SM4019S
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)					30
Form of crediting	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / 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)					1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)					0,6

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of IT systems.
2. Basic knowledge of the construction and operation of computer networks.
3. Basic skills for searching, systematizing, and presenting knowledge.

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SUBJECT OBJECTIVES

C1 Providing students with basic skills related to preparation and presentation of scientific texts, beginning from the choice of topic, selection of tasks to be performed, use of literature to the interpretation of the results.
C2 Preparing students to make a short presentation.
C3 Stimulate students to follow the latest trends in the development of information and telecommunication technologies.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Knowledge of recent advances in computer science and telecommunication

relating to skills:

PEU_U01 Ability to analyze scientific and professional texts, beginning from the choice of topic, selection of retrieved information in the Internet, use of traditional literature, and to interpret the presented ideas, as well as to prepare multimedia presentation.

PEU_U02 Ability to present some specific topics and interest others with them.

PEU_U03 Ability to conduct a scientific and professional debate.

relating to social competences:

PEU_K01 Consciousness of the significance of new advances in the development of information and telecommunication technologies.

Seminar		Number of hours
Semin 1	Introduction. Rules related to student presentations. Review of basic skills related to preparation and presentation of scientific texts by students, beginning from the retrieval and choice of information in the Internet, use of traditional literature, selection of tasks to be performed, and also preparation of a short report. Determining the schedule of student presentations. The topics listed below can be adapted to current development trends.	1
Semin 2	Human-computer interface: intelligent interfaces, brain-computer interface, natural language question answering, chatbots, virtual assistants, voice interaction, VR and AR.	2
Semin 3	High-performance computing and quantum computing.	2
Semin 4	Autonomous intelligent vehicles.	2
Semin 5	Intelligent crimes: deepfakes, driverless vehicles as a weapon; tailored phishing, disrupting AI-controlled systems, large-scale blackmail, AI-authored fake news, burglar bots.	2
Semin 6	Security in the Web. AI-assisted stalking on social media. Forgery of content such as art or music.	2
Semin 7	TeleMedicine.	2
Semin 8	BlockChain: principles, typology, application area.	2
	Total hours	**15**

TEACHING TOOLS USED

N1. Books and handbooks. Literature related to the scope of the realized topic selected by a student as well as recommended by the teacher.

N2. Online materials in the Web.

N3. Documents available for students in a faculty e-learning system.

N4. Digital projector and analog pointer for presentations at the seminar.

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_U02 PEU_U03	Based on active participation in discussions.
P	PEU_U01 PEU_W01	The quality of prepared final presentations and reports.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] The Gartner Top 10 Strategic Technology Trends for 2022 https://www.gartner.com/en/information-technology/insights/top-technology-trends
[2] B. Gupta, G.M. Pérez, D.P. Agrawal, D. Gupta (reds.): Handbook of Computer Networks and Cyber Security : Principles and Paradigms. Cham : Springer Nature Switzerland AG, 2020.
[3] A.R. Hurson: Advances in Computers, Academic Press 2021
[4] K. Sandhu: Handbook of Research on Advancing Cybersecurity for Digital Transformation. IGI Global 2021

SECONDARY LITERATURE:

[1] The 25 Biggest Failed Google Products, https://www.failory.com/blog/google-failed-products
[2] Top Computer Science Trends 2022, https://www.create-learn.us/blog/top-computer-science-trends/
[3] M. Frot: 5 Trends in Computer Science Research https://www.topuniversities.com/courses/computer-science-information-systems/5-trends-computer-science-research
[4] N. Duggal: Top 18 New Technology Trends for 2022, https://www.simplilearn.com/top-technology-trends-and-jobs-article

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Zał. nr 5 do ZW 16/2020

FACULTY of Information and Communication Technology

SUBJECT CARD

Name of subject in Polish: Metodologia badań

Name of subject in English: Research Methodology

Main field of study (if applicable): Applied Computer Science

Specialization (if applicable): Computer Engineering

Profile: academic

Level and form of studies: 2nd level, full-time

Kind of subject: obligatory

Subject code W04IST-SM4010G

Group of courses YES

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

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.

SUBJECT OBJECTIVES

C1 Providing the knowledge of definitions, characteristics and theories of research. Main components in research processes. Types of research. Research in computer science. Criteria for selecting problems for research. Analyzing and formulating the research problem. Literature collecting and review. Definition of the science objectives. Types of research methods. Phases in research process. Methods of measurement.

C2 Educating the abilities of organization of research, research report. Creation of science papers and science presentations.

C3 Acquiring competence in applying new research methods to contemporary computer engineering.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Student has a widened and deepened knowledge about definitions, characteristics and theories of research. He has a knowledge about analyzing and formulating the research problem, fundamental methods of analysis, phases in research process, data collection and measurements, writing the research proposals, reports, papers and preparation of science presentations.

PEU_W02 Student knows methodology of contemporary research in computer science and software engineering.

relating to skills:

PEU_U01 Student can understand the research process and contemporary research methods. He can apply knowledge related to providing science research, collecting and analysing data, preparing science report, science paper and science presentation.

PEU_U02 Student can identify and describe science problems and select appropriate methods to conduct the correct research process.

relating to social competences:

PEU_K01 Student has competence for solving ethical and social problems related to contemporary research in computer science.

PEU_K02 Student can cooperate and research in a group.

PROGRAM CONTENT

	Lectures	**Number of hours**
Lec 1	Introduction to philosophy of science and research methodology. Short history notes.	2
Lec 2	Introduction to research. Definitions, characteristics and theories of research. Main components in research processes. Types of research. Research in computer science.	2
Lec 3	Problem identification and topic selection. Literature collecting and review. Sources of information. Selecting, indexing and verification.	2
Lec 4	Analyzing and formulating the research problem statement. Exploring and defining research objectives.	2
Lec 5	Research Methods. Types of methods and their selection. Plans and documentation. Formulation of research hypothesis.	2
Lec 6	Methods of measurement. Single and multi-item measures. Indexing and scaling. The special role of measurement in research. Strategies. Accuracy and precision of measurements.	2
Lec 7	Models in scientific research. Model selection and verification.	2
Lec 8	Data in research. Types of data. Data collection, data preparation, data processing, calculations and documentation.	2
Lec 9	Statistical methods. Statistical calculations and hypotheses. Limitations of statistical methods. Verification of research hypothesis.	2
Lec 10	Analytical methods. Mathematical models and their solution.	2
Lec 11	Mathematical models and real data in scientific research.	2
Lec 12	Software in scientific research. Reliability and accuracy of calculations.	2

Lec 13	Reports and publications. Types. Preparation of publications. Academic style of writing papers. Presentations of research results.	2
Lec 14	Final test	2
Lec 15	Applying new research methods to contemporary computer engineering. Ethics of scientific research.	2
	Total hours	30

TEACHING TOOLS USED

N1. Multimedia presentations
N2. The course Web page
N3. Electronics and paper books and library references

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), C – concluding (at semester end)	Learning outcomes number	Way of evaluating learning outcomes achievement
F1	PEU-W01, PEU-W02, PEU-U01, PEU-U02, PEU-K01, PEU-K02	Partial tasks, quizes, activity. Final test
F2	PEU-W01, PEU-W02, PEU-U01, PEU-U02, PEU-K01, PEU-K02	The completion of laboratory exercises.
C=F1+F2		Points - evaluation: [0-51) - 2.0 [51-60) - 3.0 [61-70) - 3.5 [71-80) - 4.0 [81-90) - 4.5 [91-100+) - 5.0 A grade of 5.5 can be obtained for knowledge and activity that goes far beyond the scope of the lecture material.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

1] Creswell J.W.: Resarch Design: Qualitative, Quantitative, and Mixed Approaches. Sage Publications 2008.
[2] Packer M.: The Science of Qualitative Research. Cambridge University Press 2010.
[3] Kuipers T.A.F.: General Philosophy of Science: Focal Issues. Elseviere 2007.
[4] Alcorn V. F.: Fundamentals of Research Methodology. Omnia Science 2020.

SECONDARY LITERATURE:

[1] Collins H., Pinch T.: The Golem. What You Should Know about Science. Cambridge University Press

2003.
[2] Chalmers A.F.: What is this thing called Science?, Latest ed., Open University Press, (Previous edition can be used if the course leader is informed before the examination.).
[3] Denning P.J., et al.: Computing as a Discipline, Communications of the ACM, vol 12, no 1, Jan 1989.
[4] Hägglund S. (ed.): Selected term papers on Methodology of Research in Computer Science, Vol II, Lecture Notes, IDA, LiTH, 1997
[5] ACM Self Assessment Procedure XXII: Ethics, CACM, vol 33, no 11, November 1990.
[6] Kock K.: A Case of Academic Plagiarism. Comm of the ACM, vol 42, no 7, July 1999.
[7] Simon H.: Understanding the natural and the artificial worlds, The Sciences of the Artificial, pp 3-29, 3rd printing, 1984.
[8] Smith A.J.: The task of the Referee, IEEE Computer, vol 23, no 4, April 1990
More reading material will be added during the course.
[9] Sandewall E.: *The Methodology of Design Iteration for Systems-oriented Research in Computer Science. http://www.ida.liu.se/ext/caisor/pm-archive/morador/001/index.html*
[10] Selected scientific papers

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Zał. nr 5 do ZW 16/2020

FACULTY of Information and Communication Technology

SUBJECT CARD

Name of subject in Polish: Projektowanie Systemów Informatycznych
Name of subject in English: Software System Development
Main field of study (if applicable): Applied Computer Science
Specialization (if applicable): Computer Engineering
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W04IST-SM4008G
Group of courses: YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	**30**			**30**	**15**
Number of hours of total student workload (CNPS)	**90**			**90**	**30**
Form of crediting	Examination / ~~crediting with grade~~*	Examination / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*
For group of courses mark final course with (X)	**X**				
Number of ECTS points	**3**			**3**	**1**
including number of ECTS points for practical (P) classes	**0**			**3**	**0**
including number of ECTS points for direct teacher-student contact (BK) classes	**1.8**			**1.8**	**0,6**

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. A student has fundamental knowledge from software engineering: basic processes, life-cycle models, modelling, and specification languages.
2. A student knows any object-oriented programming language.
3. A student knows how to design, create, and use relational database.

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SUBJECT OBJECTIVES

C1. To familiarize students with modern software development processes
C2. To allow students to gain practical experience from application of a selected process (resulting with at least a minimal set of documents) to the development of a software system
C3. To develop students' skills that will enable them to assess the quality of a software product at early stages of development

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01 A student knows different models used during software system development and understands the role of modeling

PEU_W02 A student knows typical processes (phases) of software development, their work products, and relationships among them

PEU_W03 A student knows methods used for quality assessment of software projects (and particular work products)

relating to skills:

PEU_U01 A student designs an architecture of distributed software system using appropriate languages and tools according to the selected development process

PEU_U02 A student implements a software system in accordance to the project

PEU_U03 A student defines tasks aiming at realization of specific engineering problems, and estimates their duration

PROGRAM CONTENT

Lectures		**Number of hours**
Lec 1	Introduction	2
Lec 2	Project goals and objectives	1
Lec 3	Stakeholders	1
Lec 4	Information system domain	2
Lec 5	Scope and context of the project	2
Lec 6	Requirements management	6
Lec 7	Project risk management	4
Lec 8	Project time management	2
Lec 9	Project costs estimation	2
Lec 10	Overview of managerial activities	2
Lec 11	The Unified Process	2
Lec 12	Business process modelling	2
Lec 13	Lecture test	2
	Total hours	**30**

Project		**Number of hours**
Proj 1	Inception phase	2
Proj 2	Elaboration phase – Requirements and analysis	4
Proj 3	Elaboration phase – Design	8
Proj 4	Elaboration phase – Implementation and tests	14
Proj 5	Final grading	2
	Total hours	**30**

Seminar	**Number of hours**

Sem 1	Introduction, assignment presentation topics	1
Sem 2	Presentation of topics by students	13
Sem 3	Final grading	1
	Total hours	**15**

TEACHING TOOLS USED

N1. Informative lecture supported by multimedia presentations
N2. Examples of documents or templates
N3. CASE tool, IDE used for programming and testing
N4. E-learning system used for materials publication

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 - lecture	PEU_W01, PEU_W02, PEU_W03	Test. The grade calculated on the base of sum of points: $$\boldsymbol{F1} = \frac{\text{points scored on the test}}{\text{maximum number of points on the test}}$$
F2 - project	PEU_U01, PEU_U02, PEU_U03	A grade proposed to a student taking into account the quality of the software product and all intermediate documents; the engagement of the person in software development (the number of tasks, their accuracy, etc.) $$\boldsymbol{F2} = \frac{\text{points scored on the project}}{\text{maximum number of points on the project}}$$
F3 - seminar		The substantive correctness of the presentation and the legibility of the presented content are assessed, i.e. visual legibility and clarity of the oral message. $$\boldsymbol{F3} = \frac{\text{points scored on the seminar presentation}}{\text{maximum number of points on the seminar presentation}}$$

P – final grade condition:
if $F1 > 0.5 \; and \; F2 > 0.5 \; and \; F3 > 0.5$ **then**

$$\boldsymbol{P} = 0.4 \cdot \boldsymbol{F1} + 0.4 \cdot \boldsymbol{F2} + 0.2 \cdot \boldsymbol{F3}$$

else

$$\boldsymbol{P} = 0$$

Lower bound (P)	Upper bound (P)	Grade
≥ 0%	≤ 50%	2.0
> 50%	≤ 60%	3.0

> 60%	≤70%	3.5
> 70%	≤ 80%	4.0
> 80%	≤ 90%	4.5
> 90%	≤ 95%	5.0
> 95%	≤ 100%	5.5

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] L. Maciaszek, B.L. Liong, Practical software engineering: a case study approach, Pearson Addison Wesley, 2005
[2] P. Kroll, P. Kruchten, The Rational Unified Process Made Easy: A Practitioner's Guide to the RUP, Addison-Wesley Object Technology Series, 2003

SECONDARY LITERATURE:

[1] Per Kroll, Agility and Discipline Made Easy: Practices from Open UP and RUP, Addison-Wesley Professional, 2006
[2] OpenUP description (Eclipse project)

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

Marek Krótkiewicz, marek.krotkiewicz@pwr.edu.pl

Zał. nr 5 do ZW 16/2020

Faculty of Information and Communication Technology

SUBJECT CARD

Name in Polish: Projektowanie doświadczeń użytkownika
Name in English: User Experience
Main field of study (if applicable): Applied Computer Science
Specialization (if applicable): Computer Engineering
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W04IST-SM4022G
Group of courses: YES

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

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of methods and techniques of data analysis
2. Designing and implementing web systems skills

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SUBJECT OBJECTIVES

C1 To get knowledge in the field of user experience design
C2 To acquaint with the methods of testing usability of interactive systems
C3 To design and implement interactive systems based on natural user interface
C4 To verify usability and availability of implemented interactive systems.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 student has ordered knowledge of designing and managing complex interactive systems, especially connected with user experience and interaction;

PEU_W02	student knows methods of usability and user experience testing dedicated to various stages of the life cycle of facilities and IT systems
relating to skills:	
PEU_U01	student is able to project – according to fixed specification – an information system, especially user interaction and integration with other systems; student is able to realize the project, at least in part
PEU_U02	student is able to plan and perform usability tests of user interface and user experience tests, student is able to judge existing information solutions and to propose the improvements

PROGRAMME CONTENT		
Lectures		**Number of hours**
Lec 1	Research area "User Experience"	2
Lec 2	Interaction Design	2
Lec 3	Interaction concept. Understanding user needs	2
Lec 4	Design, prototyping, construction	2
Lec 5	Testing and evaluation of interactions	2
Lec 6	Usability of interactive systems	2
Lec 7	Typology of usability testing methods	4
Lec 8	Optimization, project improvement	2
Lec 9	Heuristic usability study	2
Lec 10	Usability study with users	2
Lec 11	Analyzing and reporting results	4
Lec 12	IT system personalization	2
Lec13	Final test	2
	Total hours	30

Project		**Number of hours**
Proj 1	Overview of the course organization. Safety instructions.	2
Proj 2	IT project design	4
Proj 3	Implementation of IT system logic	4
Proj 4	Design and implementation of user interface	4
Proj 5	Implementation of IT system interactions	6
Proj 6	Study of usefulness of IT system	6

Proj 7	Demonstration of the system	4
	Total hours	30

TEACHING TOOLS USED
N1. Lecture N2. Consultations N3. To get to know with basic items and expanded literature by the student N4. Project exercises in the computer laboratory N5. Student's own work - preparation for laboratory classes N6. Develop reports of 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
F – project	PEU_U01 PEU_U02	Notes for each part of project and reports
P – project and lecture	PEU_U01 PEU_U02 PEU_W01 PEU_W02	Average note from part notes and final test

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Mościchowska I., Rogoś-Tuerk B.: *Badania jako Podstawa Projektowania User Experience*. Wydawnictwo Naukowe PWN, 2015

[2] Sharp, H., Rogers, Y., & Preece, J., *Interaction Design: beyond human-computer interaction*. New York: John Wiley & Sons, Inc. 4nd Edition 2015

[3] Garrett J. J*., The Elements of User Experience: User-Centered Design for the Web and Beyond*, Second Edition. New Riders 2011

[4] Chapman N., Chapman J., *Digital media tools. Third edition*. Ontario: John Wiley & Sons Ltd., 2009.

[5] Sikorski M., *Interakcja Człowiek-Komputer*. Wydawnictwo PJWSTK 2010.

[6] Sobecki J., *Rekomendacja interfejsu użytkownika w adaptacyjnych webowych systemach informacyjnych*. *Wrocław*: Oficyna Wydawnicza Politechniki Wrocławskiej, 2009.

[7] Goodman E., Kuniavsky M., Moed A., Observing the User Experience: A Practitioner's Guide to User Research. Elsevier 2012.

[8] Sauro J., Lewis J. R., Quantifying the User Experience: Practical Statistics for User Research. Elsevier 2012.

SECONDARY LITERATURE:

[1] Ginsburg S., Designing the iPhone User Experience: A User-Centered Approach to Sketching and Prototyping iPhone Apps, Addison-Wesley, 2011.
[2] Marcus A., Wang W. (Eds), Design, User Experience, and Usability. Practice and Case Studies. Springer 2019.
[3] Ahram T. Z., Falcão Ch. S., Advances in Usability, User Experience, Wearable and Assistive Technology. Proceedings of AHFE 2021.

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

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Zał. nr 5 do ZW 16/2020

FACULTY Information and Communication Technology

SUBJECT CARD

Name in Polish: : Projektowanie gier komputerowych
Name in English: Video Game Design
Main field of study (if applicable): Applied Computer Science
Specialization (if applicable): Computer Engineering
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W04IST-SM4109G
Group of courses: YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30			30	
Number of hours of total student workload (CNPS)	60			90	
Form of crediting	crediting with grade			crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	2			3	
including number of ECTS points for practical (P) classes				3	
including number of ECTS points for direct teacher-student contact (BU) classes	1,2			1,8	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of software design.
2. Ability to process multimedia information at basic level.
3. Practical knowledge of basic technologies in online systems.

SUBJECT OBJECTIVES

C1. To acquaint students with basic issues of designing and developing video games.
C2. To introduce students to the problems of domain integration in video game development workflow.
C3. To provide practical skills of game design and prototyping using existing components and libraries.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 Basic knowledge about designing and developing video games.
PEU_W02 Knowledge enabling the characterization of domain and roles in video game development process.
PEU_W03 Knowledge about tools for video game design and prototyping.

relating to skills:
PEU_U01 The use of tools for video game design and prototyping for selected platforms.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec 1	History of video games	2
Lec 2	Classification of video game genres and platforms	2
Lec 3	Process of video game development (milestones)	2
Lec 4	Roles in the process of development	2
Lec 5	Games in Virtual Reality	2
Lec 6	Mobile gaming	2
Lec 7	GDD and prototyping	2
Lec 8	Game feel	2
Lec 9	Narrative design	2
Lec 10	Gameplay design	2
Lec 11	Level design principles and best practices	2
Lec 12	Level editors	2
Lec 13	Game hacking and mods	2
Lec 14	Cooperation and MMORPG	2
Lec 15	Indie games and video game trends	2
	Total hours	30

Form of classes - project		**Number of hours**
Proj 1	Choosing project subject.	2
Proj 2	Video game design.	4
Proj 3	Project implementation – sprint 1	4
Proj 4	Project implementation – sprint 2	4
Proj 5	Project implementation – sprint 3	4
Proj 6	Project implementation – sprint 4	4
Proj 7	Project implementation – sprint 5	4
Proj 8	Project outcome presentation	4
	Total hours	30

TEACHING TOOLS USED
N1. Multimedia presentations and videos introducing and illustrating the subjects presented in the lecture. N2. Practical introduction to using developer software via remote desktop / projector. N3. Online learning management system (moodle) for communication and monitoring progress of student learning.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1 – progress evaluation after sprint 3	PEU_U01 PEU_W03	Individual conversation with project team members.
C1 – final mark for lecture	PEU_W01 PEU_W02 PEU_W03	Multiple choice test
C2 – final evaluation of the project	PEU_U01 PEU_W03	Final mark after the presentation of a finished project.
P: the final evaluation shall take into account the test result C1 and the project evaluation C2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[7] Rollings, Andrew & Morris, Dave: Game Architecture and Design, New Riders, ISBN-10: 0735713634, ISBN-13: 978-0735713635, 2012

[8] J. F. DiMarzio: Tworzenie gier na platformę Android 4 (tyt. org.: Practical Android 4 Games Development; tł. Szymon Pietrzak), Helion, 2013

[9] Gabe Zichermann, Christopher Cunningham : Grywalizacja. Mechanika gry na stronach WWW i w aplikacjach mobilnych (tyt. org.: Gamification by Design: Implementing Game Mechanics in Web and Mobile Apps; tł. Rafał Jońca), Helion, 2012

SECONDARY LITERATURE:

[1] Adams, Ernest & Rollings, Andrew: Fundamentals of Game Design, Prentice Hall, ISBN-10: 0131687476, ISBN-13: 978-0131687479, 2006

[2] Rabin, Steve: Introduction to Game Development, Charles River Media. ISBN-10: 1584503777, ISBN-13: 978-1584503774, 2005

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