Annex to Resolution No. 538 of the Senate of the University of Lodz dated 23.06.2023.

WYDZIAŁ
MATEMATYKI
i INFORMATYKI
Uniwersytet Łódzki

CURRICULUM

COMPUTER SCIENCE

First-cycle

general academic profile

effective from the academic year 2023/24

Study programme approved by the Council of the Faculty of Mathematics and Computer Science on 17.05.2023

1. **Course programme** – COMPUTER SCIENCE

2. **Brief description of the course**

First-cycle studies in *Computer Science* at the Faculty of Mathematics and Computer Science at the University of Lodz are intended for all candidates interested in applying computer science in their future professional career, whether in private enterprises, public offices or educational institutions.

The idea behind the *Computer Science* programme is to provide students with knowledge and skills about the basic branches of modern computer science. These studies guarantee a general academic education with a high potential for practical application. In addition to mathematical preparation and a solid foundation in programming, algorithmics, computer networks, databases and software engineering, the student also gains specific skills in the narrower branches of computer science of their choice through the selection of specialisation blocks. These blocks are adapted to current and anticipated challenges in the labour market. Examples of specialisation blocks are: *Programming* (a block designed for future system architects and programmers), *Computer Networks* (a block designed for future network architects and computer system administrators), *Computer Graphics* (a block designed for future computer graphic artists, designers of graphical interfaces and multimedia systems), *Game Design* (a block designed for future computer game programmers) and *Databases* (a block designed for database system architects and analysts). The basic offer and specialisation blocks are extended by a wide range of elective classes that enable furthering knowledge in particular areas of interest to the student.

A variety of classes, including numerous classes in computer labs, allow students to master various techniques related to information processing. Particular emphasis in the educational process is placed on developing the skills of analytical thinking, teamwork and use of the relevant literature references.

The studies shall be organised in such a way that the third year students of the Faculty should have the opportunity to spend one semester at one of the foreign universities with which the University has signed appropriate agreements under the ERASMUS programme.

3. **Degree level –** first-cycle studies

4. **Profile of studies –** general academic

5. **Form of study –** full-time

6. **Educational goals**

The goals of education in the first-cycle studies of *Computer Science* are as follows:

- to educate specialists with in-depth knowledge and skills in the basic areas of information technology;
- to impart knowledge and skills in information technology, including algorithmics, programming, databases, computer systems and networks, Internet technologies, and information system architecture;
- to develop the ability to think analytically and synthetically, allowing the graduates to solve practical problems that require the adaptation of relevant information technologies;
- English language teaching to enable the graduate to achieve communication skills at the B2 level;
- to familiarise students with the basics of entrepreneurship and aspects of law, including data protection;

- to prepare the graduates for research, independent development of professional skills, and for entry into second-cycle or post-graduate studies.

Depending on the specialisation blocks selected, the educational goals are:

- to prepare the graduate in the development of software that achieves the designed purposes in a wide range of fields, using tools to achieve the final result in an optimal way, in terms of objectively verifiable quality,
- to prepare the graduate for positions requiring the ability to design and maintain information systems, audit and ensure the security of such systems, manage and administer network systems.
- to prepare the graduate in graphic design, creating vector and raster graphics and 3D graphics, designing graphic interfaces, creating animation and special effects, editing videos, designing websites and multimedia applications. The block provides the opportunity to gain competence in graphic design, application UX/UI, as well as programming applications that generate graphics for visualisation and computer simulations.
- to prepare the graduate in the areas of design, implementation, deployment and maintenance of database systems. The block covers complex aspects of database server administration, advanced programming in languages that are procedural extensions of query languages, data flow process modelling and implementation of business intelligence solutions.
- to prepare the graduate in the areas of design and development of games, creating graphics for games and designing scenes and maps for game scenarios. The block provides the opportunity to gain competence in the optimal design and development of computer games, along with the selection of an appropriate working environment and the application of mechanisms used in games.

7. Professional degree – BACHELOR

8. Employment opportunities and continuation of education of a graduate

The following are indicated as examples of professions[1] (with classification numbers) that graduates of the first-cycle studies in *Computer Science* can perform immediately after completing their studies, the relevant blocks of subjects for the selection of the corresponding specialisation blocks, or only after completing additional courses or obtaining appropriate certificates in the case of professions that require such additional qualifications:

- **2166 Graphic and multimedia designers** (all);
- **2513 Web and multimedia application designers** (251301 Website architect, 251303 Web development specialist);
- **2514 Applications programmers** (all);
- **2519 Computer systems analysts and programmers not elsewhere classified**;
- **2521 Database designers and administrators** (252101 Database administrator, 252103 Database designer);
- **2522 Computer systems administrators** (252201 Computer systems administrator);
- **2523 Computer network professionals** (252301 Computer network analyst, 252302 Computer systems and networks engineer);
- **2529 Database and computer network professionals not elsewhere classified** (252901 Software security specialist, 252902 Security specialist).

[1] Ordinance of the Minister of Family and Social Policy of November 13, 2021 amending the Ordinance on the classification of professions and specialisations for the needs of the labour market and the scope of its application – Journal of Laws 2021, item 2285.

The graduates will be prepared to independently develop their professional skills and to pursue a second-cycle or post-graduate studies in *Computer Science, Data Analysis* or related fields.

9. Prerequisites, expected competencies of the candidate

A candidate for the first-cycle programme in computer science should have:

- knowledge and skills in mathematics and computer science at the secondary school level.
- English language skills at the B1 level of the Common European Framework of Reference for Languages.

10. Areas and disciplines to which the education outcomes apply

Science field: computer science (leading discipline) – 70% of education outcomes; mathematics – 16% of education outcomes. Engineering and technical sciences field: computer engineering and telecommunications – 14% of the education outcomes.

11. Course-related education outcomes for the type of qualification with reference to the component of the description of the first and second cycle characteristics in the PRK Polish Qualifications Framework

The *Computer Science* programme, taught at the Faculty of Mathematics and Computer Science of the University of Lodz, allows to achieve the course-related effects described in Table 1.

Tabele 1. Reference of the course-related education outcomes to the characteristics of the Polish Qualifications Framework (PRK).

Symbols for course-related education outcomes	Descriptions of course-related education outcomes.	Reference to the description component of the first and second-cycle characteristics of the PRK (I and III).
	The graduate:	
11I-1A_W01	has advanced knowledge of higher mathematics (in particular discrete mathematics, algebra, mathematical analysis and probability)	P6S_WG
11I-1A_W02	has an advanced level of knowledge of the mathematical and formal foundations of computer science	P6S_WG
11I-1A_W03	has knowledge of information technology in the areas of advanced algorithmics, programming, data structures, data representation and processing, among others	P6S_WG
11I-1A_W04	has an advanced level of knowledge of the computational methods used in solving computer problems	P6S_WG
11I-1A_W05	has advanced knowledge of IT infrastructure and devices, including operating systems, computer networks, and aspects of data organisation and management	P6S_WG P6U_W
11I-1A_W06	has knowledge of methods, techniques and tools used in solving advanced tasks in the design and construction of information systems, operating systems, computer networks and distributed systems, databases, software engineering and embedded systems	P6S_WG
11I-1A_W07	knows the basics of programming engineering, life cycle and software development environments	P6S_WG P6U_W
11I-1A_W08	knows the basic principles of health and safety at work, especially the use of computer equipment	P6S_WG P6S_WK

11I-1A_W09	has a basic knowledge of the civilisational, social and legal conditions of the application of information technology, including copyright and industrial property protection, in particular in the acquisition, processing and sharing of data	P6S_WK
	The graduate:	
11I-1A_U01	uses the language and tools of higher mathematics (in particular discrete mathematics, algebra, mathematical analysis and probability), including with application to modelling data and information processes	P6S_UW
11I-1A_U02	defines and interprets functional relationships; applies theorems and methods of differential calculus of functions of one and many variables, among others, in problems related to the study of the course of functions and optimisation	P6S_UW
11I-1A_U03	carries out simple inferences using mathematical apparatus and computer tools	P6S_UW
11I-1A_U04	models and solves discrete problems	P6S_UW
11I-1A_U05	uses tools, software packages and computational techniques to solve selected mathematical, computer science and data analysis problems	P6S_UW
11I-1A_U06	is able to perform the specification of a computer problem and its algorithmic solution using advanced algorithms, data structures and programming methodologies	P6S_UW P6U_U
11I-1A_U07	has the ability to select hardware, software and system solutions and configure them and evaluate their performance	P6S_UW P6S_UO, P6U_U
11I-1A_U08	independently performs and develops projects of information systems, is able to formulate conclusions of their own research	P6S_UW, P6U_U
11I-1A_U09	can plan and carry out selected experiments, including measurements and computer simulations, analyse and interpret their results	P6S_UW
11I-1A_U10	is able to present correct mathematical and algorithmic reasoning in an understandable manner, both orally and in writing	P6S_UK, P6U_U
11I-1A_U11	forms opinions on basic computer issues in understandable, colloquial language; refers and comments on the latest developments and trends in computer science	P6S_UK, P6U_U
11I-1A_U12	speaks at least one modern foreign language at the level of (B2), particularly in the field of computer science	P6S_UK, P6U_U
11I-1A_U13	is able to work as a team on projects that are long-term in nature	P6S_UO, P6U_U
11I-1A_U14	independently acquires knowledge and develops their skills, using literature and modern technologies.	P6S_UU P6U_U
	The graduate	
11I-1A_K01	has a critical approach to the information received, sees the need to verify it	P6S_KK
11I-1A_K02	knows the limitations of their own knowledge and understands the need for further education, is able to formulate questions with precision, serving to deepen their own understanding of a given topic	P6S_KK
11I-1A_K03	organizes work well, appropriately determines priorities for the implementation of a specific task or project, taking into account the public interes	P6S_KO, P6U_K
11I-1A_K04	observes the principles of respect for intellectual property in their own actions, acts ethically	P6S_KR
11I-1A_K05	applies patterns of appropriate behaviour in the social and natural environment (is responsible, systematic and self-critical), is ready to take up employment in the field of Information Technology	P6S_KR P6S_KO P6U_K

12. Conclusions from the analysis of the compliance of education outcomes with the needs of the labour market and the social environment, conclusions from the analysis of the results of monitoring the professional careers of graduates and proven international standards

Employers affiliated with the Business Council at the Faculty are indirectly involved in the process of writing and verifying education outcomes. Members of the Business Council pay attention to the course-related effects in connection with the subjects pursued during the course of study, but also to the need for graduates to obtain education outcomes in terms of social competencies, such as the ability to work in a team, conciliation, communication skills, the development of appropriate ethical attitudes, the ability of a future employee to self-improve, motivation to work and knowledge of foreign languages. IT employees are still in demand in the market. Also important for the proper application of international patterns in the curriculum of the computer science course are the observations and experiences of academics from their stays at foreign partner universities, such as: *University of Paderborn, Faculty of Computer Science, Electrical Engineering and Mathematics; University of Ioannina*, *Department of Computer Science and Engineering; Università degli Studi dell'Insubria, Department of Theoretical and Applied sciences*. The study programme checked international benchmarks and took into account the educational standards of *Bachelor of Science in Computer Science* programmes that are implemented at universities ranked in the QS *World University Rankings by Subject 2022: Computer Science and Information Systems*

13. Relationship to the university's mission and development strategy

The *Computer Science* course is well aligned with the mission of the University of Lodz, in particular in terms of building competencies that provide graduates with a good start in the labour market, as well as in terms of creating and deepening relations with the socio-economic environment. In the area of education, the University's mission identifies three strategic goals:

- *"Continuous improvement of the quality of teaching at all levels of academic education"* – this goal is implemented in particular by improving the quality and increasing the attractiveness of taught classes, continuous monitoring of the quality of taught classes through hospitalisations, expert hospitalisations and student surveys, and programme evaluation of studies by the Faculty Education Quality Committee (WKJK).
- "*Strengthening competencies to enable graduates to find employment in line with expectations*" – Information technology is a very rapidly developing field of knowledge. The idea of offering students the opportunity to choose blocks of subjects instead of specialisations will allow the teaching offer to be more quickly adapted to current labour market requirements. The programme of the *Computer Science* course was consulted with representatives of the business environment – including the Association of Business Service Leaders (ABSL), which is the leading organisation representing the modern business services sector in Poland. The Faculty has been participating in the work of the Łódź ICT Cluster for years through the implementation of projects such as the Łódź IT Days, as well as the active participation of faculty representatives in the Cluster's teams – Education and Development and Promotion Strategy. Teaching courses include subjects taught by business representatives, who also participate in projects carried out by students.
- "*Stronger relationship between education and ongoing research*". The scientific research conducted at the Faculty, especially in the fields of artificial intelligence and theoretical computer science, enables providing students with an appropriate level of content for teaching. Students are invited to participate in scientific events held at the Faculty, such as expert lectures (also given by experienced researchers), and academic seminars.

The role of the University of Lodz is also to internationaliee its teaching offerings. The English-language studies conducted at the Faculty of Mathematics and Computer Science contribute to an increase in the number of foreign students – both in full-time studies and through exchange programmes, which is one of the university's operational goals. In addition, students of the *Computer Science* course have the opportunity to go on foreign scholarships to European universities, providing them with the prospect of studying in a diverse community and the opportunity to make international contacts.

In conclusion, when educating computer science students, we focus on modern research-based education, using the latest technologies, constantly improving the academic and teaching competence of our staff, as well as establishing contacts with the business community.

14. Differences in relation to other study programmes, with similarly defined goals and learning outcomes, conducted at the University of Lodz

The distinguishing feature of the first-cycle course in Computer Science at the Faculty of Mathematics and Computer Science is that students obtain a solid mathematical foundation (including aspects of mathematics used in computer science and theoretical computer science) and pay special attention to the algorithmic side of the issues under consideration. The course has an general academic profile, and the various specialisation blocks offered allow the student to freely choose those areas of computer science that meet their specific needs, which differentiates this programme from specialisations offered by other faculties.

The classes in the *Computer Science* course at the Faculty of Mathematics and Computer Science are conducted in two languages (Polish and English), which also distinguishes this study programme and increases the degree of internationalisation of studies at the University.

15. Study plan for the first-cycle course in *Computer Science*

Specialisation blocks and elective courses are chosen by the student from the pool offered at the Faculty in a given academic year. The list of offered blocks and subjects (with the content, form of classes, term, minimum and maximum group size), is determined and announced to students by the dean in advance. Physical education classes and Foreign Language classes are selected from the offerings presented by the university.

In the case of a Foreign Language course, the student is required to pass a foreign language exam at the university in accordance with the requirements specified for the B2 level.

The student chooses the department at which they will write their diploma, from among the units designated by the dean. The rules for selection (including the date, minimum and maximum size of seminar groups) are determined by the dean and communicated to students by May 30 of the preceding academic year.

Field of study : **Computer Science**
Profile of study: General academic
degree studies: I (Bachelor degree studies)
Mode of study: Full-time programme
For a year 2023/2024

YEAR	SEMESTER	COURSES	Course details							Modules
			Number of Hours					Form of assessment	ECTS	MK - core MW - elective
			Lectures	Tutorials / Seminars	Computer labs	Apprenticeship, others	Total			
I	1	Discrete Mathematics with Elements of Logic	28	28			56	E	**6**	MK
	1	Introduction to Programming	28		28		56	G	**6**	MK
	1	Operating Systems	28		28		56	G	**6**	MK
	1	Introduction to Computer Science	28	28			56	E	**6**	MK
	1	Legal Aspects of Computer Science	28				28	G	**3**	MK
	1	History of Computer Science	28				28	G	**3**	MK
		Total after 1st semester:				**Hours:**	**280**	**ECTS:**	**30**	
	2	Foreign Language 1		60			60	G	**2**	MK
	2	Algebra and Number Theory	28	28			56	G	**5**	MK
	2	Mathematical Analysis	28	28			56	E	**5**	MK
	2	Object-Oriented Programming	28		28		56	E	**6**	MK
	2	Computer Networks	28		28		56	E	**6**	MK
	2	Software Engineering	28				28	E	**3**	MK
	2	Computer Graphics Basics			28		28	G	**3**	MK
		Total after 2nd semester:				**Hours:**	**340**	**ECTS:**	**30**	
II	3	Foreign Language 2		60			60	G	**2**	MK
	3	Foreign Language Exam for B2 Level					0	E	**3**	MK
	3	Block S	28				28	G	**2**	MK
	3	Databases Fundamentals	28		28		56	E	**6**	MK
	3	Algorithms I	28		28		56	G	**5**	MK
	3	Physical Education 1				30	30	G	**0**	MK
	3	Elective Block 1	max	96			96	G/E	**12**	MW
		Total after 3rd semester:				**Hours max:**	**326**	**ECTS:**	**30**	
	4	Automata and Formal Languages	28	28			56	E	**6**	MK
	4	Probability with Statistics	28		28		56	E	**6**	MK
	4	Physical Education 2				30	30	G	**0**	MK
	4	Algorithms II	28		28		56	E	**6**	MK
	4	Elective Block 1	max	96			96	G/E	**12**	MW
		Total after 4th semester:				**Hours max:**	**294**	**ECTS:**	**30**	
III	5	Team Project			28		28	G	**4**	MK
	5	Introduction to Artificial Intelligence	28		28		56	E	**6**	MK
	5	Degree Project 1 and Preparation for BA		28			28	G	**3**	MK
	5	Systems Security with Elements of Cryptography	28				28	E	**3**	MK
	5	Elective Course I	max	28			28	G	**2**	MW
	5	Elective Block 2	max	96			96	G/E	**12**	MW
		Total after 5th semester:				**Hours max:**	**264**	**ECTS:**	**30**	
	6	Degree Project 2		28			28	G	**12**	MK
	6	Apprenticeship				120	120	G	**4**	MK
	6	Elective Course II	max	28			28	G	**2**	MW
	6	Elective Block 2	max	96			96	G/E	**12**	MW
		Total after 6th semester:				**Hours max:**	**272**	**ECTS:**	**30**	
		GRAND TOTAL :				**Hours max:**	**1776**	**ECTS:**	**180**	

Study programme approved by the Council of the Faculty of Mathematics and Computer Science on 17.05.2023

Examples of subjects of Block S: Success on the Labour Market, Basics of Entrepreneurship and Management.

Examples of subjects of Elective Blocks 1 and 2:

- Component Programming, Numerical Methods, Testing and Quality Assurance, Programming Web Applications, Virtualization and Containerization.
- Network Infrastructure Management, Routing in Computer Networks, Computer Networks Security, Monitoring and Management of Computer Networks, Wireless Networks.
- Image Editing Techniques, 3D Modeling and Computer Animation, Website Graphics,
  Algorithms and Data Structures in Computer Graphics, G2b_Video Editing and Special Effects, G2c_Basics of UX_UI.

16. Balance of ECTS credits with indicators describing the study programme

In accordance with current regulations at the University of Lodz, ECTS credits have been assigned to individual elements of the study programme. ECTS credits are awarded on the basis of the estimated workload of the average student as defined in the *ECTS Credit Value Determination System for subjects at the Faculty of Mathematics and Computer Science of the University of Lodz*. Contact classes and the student's own work are taken into account. It is assumed that one ECTS credit is equivalent to 25-30 hours of work for an average student.

Tabele 2. Balance of ECTS credits with indicators describing the study programme.

Balance of ECTS credits with indicators describing the study programme	Full-time programme
Number of semesters and total number of ECTS credits a student must acquire to obtain a specific qualification: 6 semesters	6 semesters, 180 ECTS credits
The total number of hours of classes, including internships, that a student must complete during the course of study (for specialisation / modules / elective subjects with different numbers of hours – the highest total number of hours)	1776 hours
Total number of ECTS credits a student must obtain from contact classes (requiring direct participation of lecturers and students)	95 ECTS credits
Total number of ECTS credits to be obtained by the student in practical skills classes	87 punktów ECTS
The number of ECTS credits that a student must obtain by completing modules of study in general courses or in another field of study	0 ECTS credits
Number of ECTS credits to be obtained by the student in the humanities or social sciences	5 ECTS credits
Number of ECTS credits a student must obtain in elective courses	62 ECTS credits

17. Description of the process leading to obtaining education outcomes

a) Descriptions of subjects (syllabuses), to the extent defined by a separate order of the Rector

Syllabuses are provided as an appendix at the end of the curriculum. A detailed description of the subjects can be found in the Subjects Catalogue of the University of Lodz and is in accordance with the requirements of the University of Lodz. The analysis of the verification of education outcomes is the subject of the work of the Faculty Education Quality Committee and the Graduation Committee.

b) Table specifying the relationship between the course-related outcomes and education outcomes defined for individual subjects or modules of the education process

Tabela 3. Matrix of learning outcomes for the course of Computer Science

Subjects / Symbols for course-related education outcomes	Discrete Mathematics with Elements of Logic	Introduction to Programming	Operating Systems	Introduction to Computer Science	Legal Aspects of Computer Science	History of Computer Science	Foreign Language 1	Algebra and Number Theory	Mathematical Analysis	Object-Oriented Programming	Computer Networks	Software Engineering	Computer Graphics Basics	Foreign Language 2	Databases Fundamentals	Algorithms I	Automata and Formal Languages	Probability with Statistics	Algorithms II	Team Project	Introduction to Artificial Intelligence	Degree Project 1 and Preparation for BA	Systems Security with Elements of Cryptography	Degree Project 2	Apprenticeship
KNOWLEDGE:	1a	1b	1c	1d	1e	1f	2a	2b	2c	2d	2e	2f	2g	3a	3b	3c	3d	4a	4b	5a	5b	5c	5d	6a	6b
11 I-1A_W01	x							x	x	x								x							
11 I-1A_W02	x							x	x																
11 I-1A_W03		x								x					x	x		x	x						
11 I-1A_W04																x	x	x	x	x					
11 I-1A_W05			x	x							x														
11 I-1A_W06			x	x							x	x			x					x					
11 I-1A_W07												x								x					
11 I-1A_W08			x								x												x		
11 I-1A_W09					x	x																x		x	
SKILLS:	1a	1b	1c	1d	1e	1f	2a	2b	2c	2d	2e	2f	2g	3a	3b	3c	3d	4a	4b	5a	5b	5c	5d	6a	6b
11 I-1A_U01	x			x				x		x						x	x		x		x				
11 I-1A_U02	x								x							x	x	x	x						
11 I-1A_U03																x		x	x						
11 I-1A_U04	x									x									x						
11 I-1A_U05				x									x		x	x			x		x				x
11 I-1A_U06		x								x						x			x	x	x				x
11 I-1A_U07			x	x							x												x		x
11 I-1A_U08			x								x				x				x			x		x	
11 I-1A_U09																x			x			x		x	
11 I-1A_U10									x	x								x		x		x		x	
11 I-1A_U11			x	x		x					x		x						x			x		x	
11 I-1A_U12							x							x						x					
11 I-1A_U13											x									x					x
11 I-1A_U14						x			x	x			x			x			x	x	x	x	x	x	x
SOCIAL COMPETENCIES:	1a	1b	1c	1d	1e	1f	2a	2b	2c	2d	2e	2f	2g	3a	3b	3c	3d	4a	4b	5a	5b	5c	5d	6a	6b
11 I-1A_K01				x	x	x		x	x				x		x	x			x		x	x	x	x	x
11 I-1A_K02		x		x		x	x	x	x	x			x	x		x		x	x		x	x	x	x	x
11 I-1A_K03					x										x	x			x	x		x		x	x
11 I-1A_K04					x	x	x		x					x	x	x			x			x	x	x	x
11 I-1A_K05			x		x				x		x											x		x	x

c) Determination of the duration, rules and form of internships

According to *the Internship Regulations* in effect at Faculty, internships are carried out on a continuous basis for 120 hours. Supervision of the proper conduct of internships is exercised by the Dean's Representative for Student Internships and internship supervisors.

d) Indication of classes that prepare students for conducting research during first-cycle studies

In the first-cycle course in *Computer Science*, classes in the module of mathematical subjects (*Discrete Mathematics with Logic, Mathematical Analysis, Algebra and Number Theory, Probability Calculus*

with Statistics), are designed to familiarise the student with the language and techniques of higher mathematics to the extent necessary for quantitative and qualitative description of research, and to impart the ability to carry out correct analytical and algorithmic reasoning. In the subjects *Algorithms I* and *Algorithms II*, students carry out projects that enable them to develop their analytical thinking skills, implement their own algorithms and modifications of known methods, and to analyse the results of conducted research and simulations using statistical tools. The rapid technological changes in the field of computer science require the education of students in the field of computer science in the area including theoretical computer science, which provides a mathematical formal apparatus that has remained unchanged for years. *Automata and Formal Languages* is designed to familiarise students with new research results in theoretical computer science, as well as the application of these research results, for example: to develop search algorithms, or to perform efficient calculations. It is worth mentioning that *Automata and Formal Languages* is a crucial subject the the Computer Science course, as the Faculty of Mathematics and Computer Science at the University of Lodz conducts important scientific research in this field, which is published in prestigious international journals. Another very important area of research conducted at the Faculty of Mathematics and Computer Science of the University of Lodz is scientific research involving artificial intelligence. The subject *Introduction to Artificial Intelligence* will enable students to get acquainted with selected aspects of artificial intelligence, both to learn about its main issues and the classes of problems it can solve. During projects and seminars, students, under the guidance of the instructor, write project papers as a preparatory element for conducting own research.

e) List and duration of mandatory training

- mandatory health and safety training on an e-learning platform;
- mandatory copyright training on an e-learning platform;
- mandatory library training on an e-learning platform.

In the fourth semester, meetings are held with students, at which the problems of research conducted by the various departments are presented, as well as the topics of the proposed diplomas.

Courses descriptions

Explanations:

Study curriculum designation:

DLIa – first-cycle curriculum in computer science conducted on a full-time basis.

Form of credit (G/E):

G – general credit,
E – exam.

Language of instruction (E/P/O):

E – English,
P – Polish,
O – obligatory in this course.

Form of classes (S/R/H):

S – contact,
R – remote,
H – hybrid.

Course title	Discrete Mathematics with Elements of Logic
Course title in Polish	Matematyka dyskretna z elementami logiki

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa	28	28			E	S/H	E	6

Short description

The aim of the course is to introduce students to basic elements of discrete mathematics and logic, in particular with set theory, relations, the principle of mathematical induction, recursion and combinatorics.

Prerequisits

Knowledge of algebra and geometry at the high school level.

The course learning outcomes

After the course the student:

E1. applies basic functors of algebra of sentences and logical laws as well as selected rules of the methods of proving;
E2. knows the basic definitions and theorems related the algebra of sets involving the rules of logic;
E3. uses the calculus of quatifiers and its properties;
E4. knows the concepts of relation and its different types as well as the abstract rules related the equivalence relations;
E5. knows the concept of function and identifies its properties and uses the concept of image and preimage of a function
E6. recognize the index families of sets and is able to examine their properties;
E7. distinguish the countable and uncountable sets and knows the essential properties;
E8. knows the definitions of floor and ceiling functions and is able to apply it;
E9. knows the basic summation methods;
E10. perform the principle of the complete mathematical induction;
E11. knows the concept of recursion and solves the simple linear recursions;
E12. uses the concept of permutation, variation, combination and determines their values.

The learning outcome codes:
W01, W02, U01, U02, U04

Course title	Introduction to Programming
Course title in Polish	Wstęp do programowania

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa	28		28		E	S/H	G	6

Short description

The course aims at introducing basics of programming in high-level languages (using a selected language). During the classes, the basic concepts and constructions used in programming (variables, simple data types, instructions, handling a basic communication with the user, subprograms, arrays) and the construction of programs using the above constructions are presented.

Prerequisits

Basic computer skills

The course learning outcomes

After the course the student:

E1. writes, compiles, and then runs programs using a development environment for a selected programming language;
E2. uses variables of simple types and of array types;
E3. uses basic instructions of the given programming language, among them conditional statements and loops
E4. writes simple subprograms;
E5. creates simple algorithms solving problems given and implements them in the given programming language.

The learning outcome codes:
W03, U06, K02

Course title	Operating Systems
Course title in Polish	Systemy operacyjne

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa	28		28		E	S/H	G	6

Short description

The subject discusses the division of software into operating system and application software with particular emphasis on the points of contact and the interface to hardware. It presents the management of processes, operating memory, storage, input/output subsystem, introduces elements of distributed systems. On the practical side, it allows you to gain skills in administering a modern server system.

Prerequisits

Proficient in the use of a workstation

The course learning outcomes

After the course the student:

E1. Can identify the tasks of the operating system;
E2. Understands process state transitions, the essence of multitasking, and system behavior under heavy load;
E3. Can estimate the optimal choice of operating memory and storage size for specific tasks;
E4. Knows the basics of process synchronization;
E5. Can prepare a universal operating system for a specific application;
E6. Can implement mechanisms for automation of the maintenance of the system.

The learning outcome codes:
W05, W06, W08, U07, U08, U11, K05

Course title	Introduction to Computer Science
Course title in Polish	Wprowadzenie do informatyki

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa	28	28			E	S/H	E	6

Short description

The aim of the course is to provide basic information necessary to understand how a computer is built, how we represent the data processed by it and what processes take place then. Students will gain practical skills related to: operating various numeral systems, operating on Boolean expressions, designing simple logic circuits.

Prerequisits

Knowledge of mathematics at the high school level.

The course learning outcomes

After the course the student:

E1. Performs conversions and arithmetic operations within any positional number systems.
E2. Correctly uses information units.
E3. Knows how to encode different types of information (e.g. alphanumeric characters, graphic file, frame of the TCP/IP protocol stack).
E4. Uses different representation formats for integers and real numbers.
E5. Analyzes and executes simple algorithms written in block diagram or pseudocode.
E6. Optimizes boolean functions.
E7. Analyzes simple logic circuits.
E8. Knows the structure of the computer and understands the purposes of its individual components.
E9. Independently searches for additional information in various materials, also in foreign languages.

The learning outcome codes:

W05, W06, U01, U05, U07, U11, K01, K02

Course title	Legal Aspects of Computer Science
Course title in Polish	Prawne aspekty informatyki

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa	28				E	S/H	G	3

Short description

The subject of the lecture is a framework presentation of issues related to the legal aspects of computing, cyber security and the protection of digital data, including personal data.

The aim of the course is to familiarise participants with the basic legal regulations applicable to digital trading, with a particular focus on cyber security and the protection of personal data. Upon completion of the course, participants will have a basic knowledge of the topics used in their daily work.

The issues discussed and the teaching methods used are among the most up-to-date and innovative on the market, both in terms of electronic data security regulation and data protection and the use of methods and interactive activities.

Prerequisits

The course learning outcomes

After the course the student:

E1. The student knows the basic challenges and threats to the application of law in cyberspace.
E2. The student is able to indicate basic legal acts concerning data processing on the Internet, including personal data.
E3.The student is able to identify basic legal acts concerning national and international secure information systems and cybercrime.
E4.The student is able to identify those areas of activity that require improvement in legal protection of data and information systems.
E5. The student is able to find specialist information to strengthen his/her position in the job market.
E6. The student is able to describe the most important legal regulations concerning the circulation of digital data and information systems.
E7. The student is able to identify security threats related to electronic circulation.
E8. The student is familiar with the meaning of effective and comprehensive digital data protection, including personal data, and is aware of the necessity of constant updating his/her knowledge within this scope.
E9. The student is aware of legislative and social changes concerning the discussed issues.

The learning outcome codes:
W09, K01, K03, K04, K05

Course title	History of Computer Science
Course title in Polish	Historia informatyki

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa	28				E	S/H	G	3

Short description

The aim of the subject is to provide the student information about the history of the creation of the first counting machines, technical inventions used in computer science and the history of development of basic IT branches.

Prerequisits

The course learning outcomes

After the course the student:

E1 - lists the basic inventions related to counting machines,
E2 - associates the names of the creators with their works,
E3 - combines the facts of computer science history with the era in which they were created,
E4 - organizes inventions and ideas chronologically,
E5 - understands the need for further education and acquiring knowledge.

The learning outcome codes:

W09, U11, U14, K01, K02, K04

Course title	Foreign Language 1
Course title in Polish	Lektorat 1

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa		60			O	S/H	G	2

Short description

Foreign language classes at B2 level, developing all language skills. Language in the IT industry and general language.

Prerequisits

Ability to speak and write a foreign language at least at B1 level.

The course learning outcomes

After the course the student:

E1. speaks quite fluently on a variety of topics in discussion;
E2. expresses his/her opinions, reacts in a variety of social situations;
E3. uses more complex grammatical constructions;
E4. uses extended vocabulary;
E5. is able to organize his/her learning process;
E6. complies with ethical standards in his/her behavior;
E7. understands the need for continuous learning.

The learning outcome codes:

U12, K02, K04

Course title	Algebra and Number Theory
Course title in Polish	Algebra i teoria liczb

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa	28	28			E	S/H	G	5

Short description

The aim of the course is to present main concepts and theorems concerning algebra and numer theory. In the field of algebra the following tasks will be discussed: complex numbers, group theory, matrices and matrices of linear transformations; in the field of numer theory we will focus on: modular arithmetic (Zp groups, congruences), prime numbers, linear diophantine equations.

Prerequisits

Knowledge of algebra and geometry at the high school level.

The course learning outcomes

After the course the student:

E1. applies basic numer theory theorems,
E2. computes GCD and LCM, applies Euclid algorithm,
E3. solves linear diophantine equations,
E4. uses modular arithmetics,
E5. knows the concept of a group and basic examples of groups, in particular, permutation groups and Zp groups,
E6. knows the definitione of a complex numer and performs computations on complex numbers,
E7. applies matrix operations, computes determinant and inverse matrix,
E8. is capable of defining a linear transformation by its matrix.

The learning outcome codes:

W01; W02; U01; K01; K02

Course title	Mathematical Analysis
Course title in Polish	Analiza matematyczna

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa	28	28			E	S/H	E	5

Short description

The aim of the course is to familiarise students with the basic tools of mathematical analysis, in particular differential and integral calculus of functions of one variable, as well as to implement in the precise formulation of questions, carrying out and presenting correct mathematical reasoning.

Prerequisits

Knowledge of mathematics at secondary school level and the laws of calculus and sets.

The course learning outcomes

After the course the student:

E1.can define and interpret functional relationships,
E2.calculates limits of sequences and functions,
E3.applies basic formulas to calculate derivatives, determines monotonicity intervals of a function and its extrema,
E4.applies basic formulas and integration techniques to calculate indeterminate integrals,
E5.can present mathematical reasoning in an understandable way,
E6.can relate mathematical concepts to everyday life and computer applications,
E7.understands the limitations of his/her own knowledge and the need for further education.

The learning outcome codes:

W01, W02, U02, U10, U14, K01, K02, K04, K05

Course title	Object-Oriented Programming
Course title in Polish	Programowanie obiektowe

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa	28		28		E	S/H	E	6

Short description

The aim of the course is to familiarize the student with the basic concepts of the object-oriented programming paradigm. In addition to the basic concepts such as class, object, class members (constructor, destructor, method), mechanisms such as data encapsulation, inheritance mechanism, static binding, dynamic binding (polymorphism) will be discussed in detail. The discussed concepts and mechanisms will be implemented in selected object-oriented languages.

Prerequisits

Knowledge of the basic issues of structured programming. Ability to work in an integrated development environment.

The course learning outcomes

After the course the student:

E1. knows the basic features of the object-oriented programming paradigm, such as: abstraction, encapsulation, encapsulation, polymorphism, and inheritance,
E2. can read with understanding and analyze simple programs written in an object-oriented programming language,
E3. can design, implement, and test classes describing a selected object from the real world,
E4. analyzes simple problems and can propose their solutions using the selected object-oriented language,
E5. formulates opinions on the proposed solutions to the considered problems.

The learning outcome codes:

W01, W03, U01, U04, U06, U10, U14, K02

Course title	Computer Networks
Course title in Polish	Sieci komputerowe

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa	28		28		E	S/H	E	6

Short description

The subject is intended to familiarise students with the principles of computer networks. Within the scope of the subject, the student learns about the functions and tasks that must be performed for communication in a network to be possible. He/she learns about local network technologies and protocols managing communication in a computer network.

On the practical side, it enables the student to gain skills in administering modern computer networks.

Prerequisits

Computer literacy and basic knowledge of operating systems from the Microsoft Windows, Linux family.

The course learning outcomes

After the course the student:

E1. knows and understands the idea of reference models of network functioning: ISO OSI and DoD
E2. has knowledge of popular communication media
E3. understands the functions and tasks of the data link layer of the ISO OSI model and knows the most important technologies of this layer
E4. understands the concept of addressing at different layers of the OSI model
E5. has knowledge of routing, analyses and selects an appropriate type of routing for a given network
E6. understands the tasks of the transport layer and on the example of the TCP and UDP protocols knows how they are implemented
E7. is able to configure basic network services (DHCP, DNS, HTTP, FTP, NAT, SMTP, POP3)
E8. understands the threats resulting from working in a network and knows the mechanisms to counteract them

The learning outcome codes:

W05, W06, W08, U07, U08, U11, U13, K05

Course title	Software Engineering
Course title in Polish	Inżynieria oprogramowania

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa	28				E	S/H	E	3

Short description

The aim of the course is to present the software development life cycle using the example of the waterfall model and the Scrum methodology.

Prerequisits

Knowledge of object-oriented programming concepts and basic database fundamentals.

The course learning outcomes

After the course the student:

E1. knows the waterfall model and can list its stages,
E2. can assign tasks to the specific stages of software development,
E3. is familiar with agile project management approach,
E4. knows the Scrum methodology,
E5. understands the importance of using version control systems, testing, and refactoring.

The learning outcome codes:
W06 , W07

Course title	Computer Graphics Basics
Course title in Polish	Podstawy grafiki użytkowej

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa			28		E	S/H	G	3

Short description

The aim of the course is to present the technique of creating and editing raster and vector graphics. As part of practical classes, students will learn to work with selected graphics packages, raster and vector graphics editors. Graphic file formats, color models used in computer graphics, rules for creating graphic projects with a given form of communication will be discussed.

Prerequisits

Ability to operate a computer (workstation).

The course learning outcomes

After the course the student:

E1. Knows the ways of presenting two-dimensional graphics.
E2. Can characterize raster graphics and vector graphics. Gives examples of the use of both types of graphics.
E3. Knows the formats of graphic files.
E4. Knows color models used in computer graphics.
E5. Can use raster and vector graphics editors.
E6. Can design and create graphic materials using computer techniques.
E7. Can choose the right tools for the job.
E8. Is able to create graphic projects with a given form of communication.
E9. Is able to prepare graphic materials intended for display on a monitor screen as well as for printing.

The learning outcome codes:

U05, U11, U14, K01, K02.

Course title	Foreign Language 2
Course title in Polish	Lektorat 2

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa		60			O	S/H	G	2

Short description

Foreign language classes at B2 level, developing all language skills. IT and general language.

Prerequisits

Ability to speak and write a foreign language at least at B1+/B2 level.

The course learning outcomes

After the course the student

E1. expresses him/herself fairly fluently on a variety of subjects in discussion;
E2. expresses opinions, reacts in a variety of social situations;
E3. uses more complex grammatical structures;
E4. uses an extended vocabulary of general and specialized IT language;
E5. is able to organize the learning process;
E6. complies with ethical standards in his/her behavior;
E7. understands the need for continuous learning.

The learning outcome codes:
U12, K02, K04

Course title	Databases Fundamentals
Course title in Polish	Podstawy baz danych

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa	28		28		E	S/H	E	6

Short description

The aim of the course is to acquaint the student with the basic concepts and elements of databases, especially with elements of the relational model of databases. The first part of the course is devoted to the relational model of databases and data modeling methodology (including the creation of the so-called conceptual model) and design patterns of relational databases. It will also be presented the theoretical rules to improve relations - normalization schemes. The main goal of the second one is the practical learning of writing script (the most of all, various types of queries) in the Oracle dialect SQL language and programming databases using selected advanced elements of the SQL language (nested queries, views).

Prerequisits

basic computer operation
basic of mathematical logic and sets theory

The course learning outcomes

After the course the student

E1. defines the basic concepts of database theory;
E2. defines the basic elements of a relational database model and knows their purpose;
E3. creates and analyzes relational database schemas and designs database ERD diagrams;
E4. uses Oracle SQL language as a tool in implementation of Oracle databases;
E5. creates and knows select objects of Oracle relational databases such that tables, views, constraints, indexes, sequences;
E6. uses Oracle SQL dialect as a tool in modifying data stored in Oracle databases;
E7. sees at least some of wider possibilities of using SQL language to modification data stored in Oracle databases applications;
E8. can verify the received information;
E9. can work on a given project, defines the needs for its implementation;
E10. observes ethical standards in his/her conduct.

The learning outcomes codes:
W03, W06, U05, U08, K01, K03, K04

Course title	Algorithms I
Course title in Polish	Algorytmy I

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa	28		28		E	S/H	G	5

Short description

The purpose of the course is to familiarize students with methods of algorithm design and analysis. Issues related to the concept of computational complexity will be discussed. Basic algorithms and data structures will be presented in the course.

Prerequisits

Basic programming skills with a high-level language.

The course learning outcomes

After the course the student

E1. Knows the concepts of algorithm, computational complexity, pessimistic, optimistic and average complexity of algorithms. Understands the meaning of asymptotic notations;
E2. Can implement algorithms using different types of data structures, such as arrays, linear lists, queues, and various algorithmic techniques, including recursion;
E3. Knows basic algorithmic techniques (divide-and-conquer, greedy, with returns, dynamic programming) and examples of their applications, classifies algorithms according to these techniques,
E4. Knows the basic search methods (linear, binary)
E5. Is able to distinguish between basic sorting methods and their classes;
E6. Can build dictionaries based on binary trees (BST, AVL, RB).

The learning outcomes codes:
W03, W04, U01, U02, U03, U05, U06, U09, U14, K01, K02, K03, K04

Course title	Automata and Formal Languages
Course title in Polish	Automaty i języki formalne

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa	28	28			E	S/H	E	6

Short description.

The course concerns the basic, theoretical models of computation and corresponding classes of languages. Students learn the classes of formal languages which constitute the Chomsky hierarchy: regular, context-free, context-sensitive and recursively enumerable. For each of these classes formalisms used to describe these languages are presented. In particular: regular expressions and finite automata for regular languages, context-free grammars and pushdown automata for context-free languages, phrase structure grammars and Turing machines for recursively enumerable languages

Prerequisits

Basic knowledge of set theory, propositional logic, mathematical induction and recursion are required.

The course learning outcomes

After the course the student

E1. Illustrates the basic concepts of formal languages

E2. Uses various methods of describing regular languages;

E3. Constructs deterministic finite automata accepting given regular languages.

E4. Uses grammars of context-free languages in applications (compilers, BNF notation);

E5. Analyses the basic theoretical models of computers (finite automata, pushdown automata, Turing machines);

E6. Applies basic theorems concerning formal languages (e.g. Kleene's theorem, set-theoretic properties of formal languages, pumping lemmas);

E7. Gives relations between sets of formal languages based on Chomsky's hierarchy;

E8. Interprets the basic concepts of computational complexity.

The learning outcomes codes:

W04, U01, U02

Course title	Probability with Statistics
Course title in Polish	Rachunek prawdopodobieństwa ze statystyką

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa	28		28		E	S/H	E	6

Short description

The aim of the course is to familiarize the student with the basics of probability theory and statistics. The basic concepts and theorems of these fields are presented, and their application is shown.

Prerequisits

The knowledge of mathematical analysis, combinatorics, logic and set theory

The course learning outcomes

After the course the student

E1. Defines the concept of probabilistic space and uses it to describe random experiments;
E2. Knows the properties of probability and conditional probability and is able to apply theorems related to them to solve probabilistic problems;
E3. Identifies basic discrete and continuous distributions and calculates their parameters;
E4. Quotes the Poisson and de Moivre-Laplace theorems and estimates the values of the respective distributions;
E5. Verifies independence or uncorrelation of random variables and determines the correlation coefficient;
E6. Knows basic statistical concepts and estimates the values of a feature based on a sample randomly selected from the population;
E7. Performs simple statistical and probabilistic inferences, also using computer tools.

The learning outcomes codes:
W01, W03, W04, U02, U03, U10, K02.

Course title	Algorithms II
Course title in Polish	Algorytmy II

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa	28		28		E	S/H	E	6

Short description

The purpose of the course is to familiarize students with selected algorithmic methods. During the course, advanced algorithms and data structures will be presented, dealing with such issues as: efficient implementations of dictionaries, compression, graph algorithms, advanced pattern search algorithms, combinatorial algorithms.

Prerequisits

Knowledge of sorting algorithms, search algorithms, knowledge of the basics of algorithm analysis. Ability to program in at least one programming language. Ability to create advanced data structures including tree structures.

The course learning outcomes

After the course the student

E1. Knows selected algorithms for finding a pattern in a text;
E2. Understands graph search algorithms;
E3. Implements basic graph algorithms;
E4. Understands algorithms for determining the minimum spanning tree;
E5. Knows how to implement an associative array using hashing;
E6. Knows how to implement algorithms using tree structures;
E7. Knows how to compare solutions to algorithmic problems in different contexts.

The learning outcomes codes:

W03, W04, U01, U02, U03, U04, U05, U06, U08, U09, U11, U14, K01, K02, K03, K04

Course title	Team Project
Course title in Polish	Projekt zespołowy

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa			28		E	S/H	G	4

Short description

The course programme covers issues of a systematic approach to the development of an IT product. During the course, adaptive methodologies for conducting IT projects will be discussed, which enable responding to high volatility of project requirements and rapid production of software in a production version. Particular emphasis will be placed on preparing students to work in programming teams, including: analysis of requirements, division of the problem into stages, assignment of tasks to team members, development of the schedule, and preparation of technical documentation.

Prerequisits

Basic knowledge of software engineering and good knowledge of at least one programming environment.

The course learning outcomes

After the course the student

E1. Can work systematically on long-term projects in a project group;
E2. Understands and applies the assumptions of the Agile Manifesto;
E3. Use selected project management software;
E4. Use the selected version control system - creating a repository, downloading a copy, synchronization;
E5. Is able to solve project problems using adaptive methodologies, e.g. SCRUM;
E6. It uses labor cost estimation metrics, e.g. mendei, as well as work scope estimation metrics, e.g. story points.
E7. Uses modern scheduling techniques, e.g. MoSCoW.

The learning outcomes codes:

W04; W06; W07; U06; U10; U12; U13; U14; K03.

Course title	Introduction to Artificial Intelligence
Course title in Polish	Wprowadzenie do sztucznej inteligencji

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa	28		28		E	S/H	E	6

Short description

The aim of the course is to present the problems that are part of artificial intelligence as broadly as possible. During the lecture we will try to define what artificial intelligence is and what classes of problems it solves. Both theory and practice related to basic methods of learning and knowledge representation will be discussed.

Prerequisits

Knowledge of mathematics at the high school level.

The course learning outcomes

After the course the student

E1. Characterizes classes of problems and areas of interest of Artificial Intelligence.
E2. Knows and describes the basic learning methods.
E3. Knows and explains the basics structures and operation of artificial neural networks.
E4. Knows the basic methods of knowledge representation.
E5. Knows the basic issues in the field of methods of artificial life (e.g. evolutionary algorithms, intelligence of ants).

The learning outcomes codes:
U01, U05, U06, U14, K01, K02

Course title	Degree Project 1 and Preparation for BA
Course title in Polish	Seminarium projektowe 1 (z przygotowaniem do egzaminu dyplomowego)

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa		28			E	S/H	G	3

Short description

The aim of the course is to prepare the student to write and defend an undergraduate thesis in computer science in the selected area of interest. The course includes the design (requirements analysis, selection of a data model), implementation and testing of a selected information system (using a database)..

Prerequisits

Structured and object-oriented programming, databases, software engineering.

The course learning outcomes

After the course the student

E1. Analyses the requirements of the information system (diploma project).
E2. Designs an information system.
E3. Justifies the choice of implementation environment in relation to the system requirements.
E4. Justifies the choice of information tools and technologies.
E5. Works efficiently within the chosen implementation environment.

The learning outcomes codes:
W09, U08, U09, U10, U11, U14, K01, K02, K03, K04, K05

Course title	Systems Security with elements of cryptography
Course title in Polish	Bezpieczeństwo systemów z elementami kryptografii

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa	28				E	S/H	E	3

Short description

The aim of the course is to familiarize students with vulnerabilities and threats occurring in today's world of digital information and ways to defend against them. In addition, basic cryptographic algorithms will be discussed.

Prerequisits

Knowledge of the basics of computer science, computer networks, operating systems, programming and databases.

The course learning outcomes

After the course the student

E1. Lists the basic concepts related to security.
E2. Creates the Information Security Policy and the risk matrix.
E3. Recognizes basic cryptographic algorithms.
E4. Characterizes various types of attacks on systems and applications and knows how to defend against them.
E5. Knows how to secure computer networks on various communication layers in a basic way.

The learning outcomes codes:

W08, U07, U14, K01, K02, K04

Course title	Degree Project 2 and Preparation for BA
Course title in Polish	Seminarium projektowe 2 (z przygotowaniem do egzaminu dyplomowego)

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa		28			E	S/H	G	12

Short description

The aim of the course is to prepare the student to write and defend an undergraduate thesis in computer science in the selected area of interest. The course includes the design (requirements analysis, selection of a data model), implementation and testing of a selected information system (using a database).

Prerequisits

Structured and object-oriented programming, databases, software engineering.
Ability to design and implement simple systems
IT systems and to obtain information from specific sources.

The course learning outcomes

After the course the student

E1. Analyses the requirements of the information system (diploma project).
E2. Justifies the choice of implementation environment in relation to the system requirements.
E3. Works efficiently within the selected implementation environment.
E4. Is able to obtain information on programming technologies from various sources (publications, Internet resources), integrate and interpret it correctly.
E5. Is able to design and implement an information system in accordance with a given specification, using appropriate technologies and tools.
E6. Can prepare and present a study (in Polish or English) presenting the results of the implementation of an information system with particular emphasis on the technologies used.

The learning outcomes codes:
W09, U08, U09, U10, U11, U14, K01, K02, K03, K04, K05

Course title	Apprenticeship
Course title in Polish	Praktyki zawodowe

Course details

Study program symbol	Number of hours Lecture	Number of hours Seminar	Number of hours Laboratory	Number of hours (internships, other)	Language of instruction (E/P/O)	Form of conducting classes (S/R/H)	Assessment form (E/G)	ECTS credits
DLIa				120	E/P	S/R/H	G	4

Short description

The aim of the course is learning how to use IT knowledge in practice, gaining the ability to work in a team or work with the customer and knowledge of the principles of market functioning companies and institutions.

Prerequisits

Depending on company / institution offering students' practice.

The course learning outcomes

After the course the student

E1. Is aware of the need to work in accordance with the principles of health and safety.
E2. Has the ability to work in a team and to execute the commands of superiors.
E3. Has the ability to make professional connections.
E4. Has the ability to work in accordance with the schedule.
PM5. Uses the acquired knowledge and skills in information technology (according to the chosen specialty) in practice.
E6. Solves problems (tasks), using a variety of methods and sources, in particular, looks up and make their selection for their suitability to solve the problem.
E7. Plans steps to accomplish the task (to solve the problem).
E8. Uses the company's software to perform the tasks.

The learning outcomes codes:
U05, U06, U07, U13, U14, K01, K02, K03, K04, K05