STUDY PROGRAMME
Name of the field of study: **Computer Science**
Specialization: Internet and Mobile Technologies
effective from the academic year: **2023/2024**

Part I. General information.

1. Name of the unit conducting study: **Institute of Computer Science**
2. Level of education: **MA Studies**
3. Educational profile: **general academic**
4. A number of semesters: **4**
5. A total number of ECTS points required to complete the study: **120**
6. A total number of hours in the course required to complete the study: **1080**
7. The programme accepted at the meeting of Institute Board on the **22.02.2023**
8. Prevailing discipline whereby more than a half of learning outcomes will be acquired, and proportional (%) share of individual disciplines whereby learning outcomes specified in the study programme will be acquired: **computer science**

Name of the prevailing discipline	Proportional (%) share of the prevailing discipline
computer science	100%
Names of individual disciplines	**Proportional (%) share of individual disciplines**
computer science	100%
Total:	**100 %**

Part II. Learning outcomes

Descriptor of second degree PRK (*Polish Qualifications Framework)* specifications	Learning outcome symbol	Learning outcome description
KNOWLEDGE, a graduate is familiar with and understands:		
P7S_WG	KP7_WG1	broadened and deepened knowledge about analyzing advanced algorithms and data structures
	KP7_WG2	deepened knowledge of analytical methods in IT applications
	KP7_WG3	deepened knowledge about modeling and analysis of information systems architecture, as well as creating models and analyzing their quality

	KP7_WG4	deepened knowledge of modeling and simulation using models of imprecision or uncertainty and the practical application of these models	
	KP7_WG5	ordered and in-depth knowledge in the field of designing and programming relational databases	
	KP7_WG6	deepened knowledge in the field of contemporary expert systems and their applications	
	KP7_WG7	deepened and structured knowledge in the field of security of digital data and information systems, including in the context of the functioning of computer networks	
	KP7_WG8	deepened knowledge about algorithms for massive parallel computations with the use of modern numerical methods and their implementation on multiprocessor, multi-core machines and graphics cards	
	KP7_WG9	structured theoretical knowledge of information techniques and technologies used in various fields	
	KP7_WG10	structured theoretical knowledge about methods of designing and programming applications used in various fields	
	KP7_WG11	deepened knowledge in the use of deep machine learning in various fields and in-depth knowledge in deep neural networks, machine learning and feature engineering.	
	KP7_WG12	deepened and structured general knowledge in the field of processing and analysis of big data sets.	
P7S_WK	KP7_WK1	knowledge about development trends and new achievements in the field of computer science	
	KP7_WK2	deepened knowledge in the field of managing and managing teams implementing IT projects	
	KP7_WK3	fundamental dilemmas of modern civilization	
	KP7_WK4	the legal and ethical aspects related to the protection of industrial property and copyright.	
	KP7_WK5	general knowledge of the principles of creation and development of various forms of entrepreneurship, especially related to the IT industry.	
SKILLS, a graduate is able to:			
P7S_UW	KP7_UW1	adapt the existing ones or construct new models in a selected area of computer science and use their realization in the implementation environment, analyzing the characteristics of information systems	
	KP7_UW2	apply models of imprecision or uncertainty and model practical issues using these models	

	KP7_UW3	implement advanced dynamic data structures and advanced algorithms	
	KP7_UW4	implement known analysis methods and make their appropriate modification depending on the applications	
	KP7_UW5	program databases using SQL extensions	
	KP7_UW6	plan an expert system which solves specific problems and implement it	
	KP7_UW7	apply models and classes of information systems security as well as methods of user identification and authentication	
	KP7_UW8	implement massive parallel processing algorithms, including in a graphic card environment	
	KP7_UW9	use the methods and mathematical models learned, modify them if necessary, for analyzing and designing applications	
	KP7_UW10	assess and compare design solutions and the process of programming applications using various information technologies, due to the set utility or economic criteria	
	KP7_UW11	design and implement or adapt existing software for selected computer science applications	
	KP7_UW12	select and use the software appropriate for selected computer science applications	
	KP7_UW13	configure devices appropriate for selected computer science applications	
	KP7_UW14	propose improvements to existing algorithms and applications used in various fields	
	KP7_UW15	assess the suitability and the possibility of using new developments in the field of computer science	
	KP7_UW16	select and optimize a solution using deep machine learning and use experimental methods to formulate and solve tasks in the area of deep neural network applications and research problems.	
P7S_UK	KP7_UK1	use a foreign language at the B2 + level with specialist terminology appropriate for computer science, allowing to express ideas, in written and oral form, on general subjects and those related to computer science	
	KP7_UK2	prepare and present a presentation about a project task, research project or a selected computer science subject, leading a discussion about this presentation	
	KP7_UK3	use a foreign language well enough to read and understand professional literature and communicate, including professional topics	

	KP7_UK4	develop the detailed documentation of a project or research task, results of an experiment, prepare a study discussing these results
P7S_UO	KP7_UO1	manage teams implementing computer science projects
	KP7_UO2	collaborate in a team implementing joint projects
	KP7_UO3	develop an IT project, its documentation, and manage the team
	KP7_UO4	act and think in a creative, enterprising and innovative way
P7S_UU	KP7_UU1	acquire information from various sources (literature, websites, databases, etc.), integrate it and make its interpretation and critical assessment, draw conclusions, formulate and fully justify opinions
	KP7_UU2	understand the need for continuous training and self-education
	KP7_UU3	carefully identify the priorities and order of activities
SOCIAL COMPETENCE, a graduate is prepared for:		
P7S_KK	KP7_KK1	understanding the limitations of own knowledge and the need for further education, including the acquisition of non-domain knowledge
P7S_KO	KP7_KO1	initiating activities necessary to take up practical activity for the development of the information society
P7S_KR	KP7_KR1	systematic familiarization with the latest trends in the development of information technologies through scientific and popular science magazines and websites
	KP7_KR2	appreciating the importance of intellectual honesty in own and other people's activities and the need of adherence to the principles of professional ethics

Part III. Description of the process whereby learning outcomes are acquired. Learning programmes ensuring the achievement of learning outcomes for the courses or groups of courses.

GROUP OF COURSES_ 1 General Education

The symbol of the learning outcome: KP7_WK3, KP7_WK4, KP7_WK5, KP7_UK1, KP7_UK2, KP7_UK3, KP7_UK4, KP7_UO4, KP7_UU1, KP7_UU2, KP7_KK1, KP7_KO1, KP7_KR1, KP7_KR2

Intellectual Property Rights (KP7_WK4, KP7_KR2): Key concepts and problems of Intellectual Property Rights. Protection of the secret. Protection of the artistic work. Protection of inventions. Protection from a creative and legal point of view of works of students. Copyright in digital technologies. Administering the intellectual property in the college and the enterprise. Comprehending the technology transfer.

Foreign Language (KP7_UK1, KP7_UK2, KP7_UK3, KP7_UK4, KP7_UU1, KP7_UU2, KP7_KR1)

COURSE_1/2A Russian: Every day use of foreign language (travel, mass media and other means of communication, global issues, education), understanding and applying IT terminology (electronic devices, IT data security, communication systems, computer engineering, development of information techniques).

COURSE_1/2B German: Every day use of foreign language (travel, mass media and other means of communication, global issues, education), understanding and applying IT terminology (electronic devices, IT data security, communication systems, computer engineering, development of information techniques).

English for IT Professionals (KP7_UK1, KP7_UK3, KP7_UK4, KP7_UU1, KP7_UU2, KP7_KR1): The use of a foreign language in work by IT professionals, the ability to understand and use advanced IT terminology (computer networks, operating systems, electronic devices, data and computer systems security, communication systems, computer engineering, development of information technology).

COURSE_1/4 and COURSE_1/5 (KP7_WK3, KP7_WK5, KP7_KO1, KP7_UO4, KP7_KK1)

Course to choose from humanities: Student chooses one of the courses from the list of humanities approved by the Faculty Council on the basis of its full description according to the pattern existing on the University of Bialystok.

Course to choose from social sciences: The student chooses one of the courses from the list of social sciences courses approved by the Faculty Council on the basis of its full description according to the pattern existing on the University of Bialystok.

GROUP OF COURSES_ 2 Main Courses

The symbol of the learning outcome: KP7_WG1, KP7_WG2, KP7_WG3, KP7_WG4, KP7_WG5, KP7_WG6, KP7_WG7, KP7_WG8, KP7_WG9, KP7_WG10, KP7_WG11, KP7_WK1, KP7_WK2, KP7_UW1, KP7_UW2, KP7_UW3, KP7_UW4, KP7_UW5, KP7_UW6, KP7_UW7, KP7_UW8, KP7_UW9, KP7_UW10, KP7_UW11, KP7_UW12, KP7_UW13, KP7_UW14, KP7_UW15, KP7_UW16, KP7_UK4, KP7_UO1, KP7_UO2, KP7_UO3, KP7_UO4, KP7_UU1, KP7_UU2, KP7_KR1, KP7_KR2

Modelling and Analysis of IT Systems (KP7_WG3, KP7_WG5, KP7_UU1, KP7_UK4, KP7_UW1, KP7_UO3, KP7_UO4, KP7_UO2, KP7_UU2): Business and object-oriented modelling methods of IT systems. UML modelling of IT system requirements, statics and dynamics. Principles of choice UML diagrams and recording of connections between theirs elements. Realization of selected UML constructions in object-oriented programming languages.

Advanced Databases (KP7_WG5, KP7_WG10, KP7_UW5, KP7_UO4, KP7_UO2): Introduction to PL/SQL. Language rules. Data types. Blocks. Variables and their scope. Conditional instructions. Loops. SQL in PL/SQL. Records. Cursors. Collections. Exceptions. Creating and using procedures, functions and packages. Triggers. Dynamic SQL: NDS and DBMS_SQL. Introduction to PL/SQL objects.

Global Optimization (KP7_WG9, KP7_WK1, KP7_UW1, KP7_UW9, KP7_UW11, KP7_UO4, KP7_UO2): Genetic algorithm. Travelling salesman problem. Evolution strategies. Randomized algorithm of „lonely seeker"; simulated annealing; tabu-

search; ant colony optimization algorithm; particle swarm optimization; artificial immune systems; clonal selection; applications of evolutionary algorithms.

Big data: processing and analysis of large data sets (KP7_WG1, KP7_WG9, KP7_WG12, KP7_UW3, KP7_UW12, KP7_UW14, KP7_UU3): Data architectures and data types. Algorithms for large-scale data processing. Data processing optimization techniques. Distributed data storage and processing systems (Hadoop, Spark). Big Data processing in the cloud.

Introduction to Fuzzy Modelling and Analysis (KP7_WG4, KP7_UW2, KP7_UO4, KP7_UU2, KP7_KR1): Fuzzy sets. Fuzziness and randomness. Types of membership functions of fuzzy sets. Arithmetic operations on fuzzy numbers. Extension principle. Fuzzy models, including fuzzy neural models. Fuzzy control using fuzzy models.

Rule-Based and Expert Systems (KP7_WG6, KP7_WK1, KP7_UW6, KP7_UW15, KP7_UO4): Using rules and facts to represent knowledge and to make decisions. The architecture and working principle of a system that uses a rule engine. Applications of the rule-based approach. Expert systems and knowledge-based systems versus business rule management systems and BRMS software. A review of technologies for developing rule-based and expert systems. Methods for acquiring knowledge and constructing rules and facts. Problems in processing rules: conflict resolution and uncertainty modeling. Hybrid AI systems that explicitly represent knowledge.

Massively Parallel Computations (KP7_WG8, KP7_WG9, KP7_WK1, KP7_UW8, KP7_UW11, KP7_UW12, KP7_UW13, KP7_UW14, KP7_UW15, KP7_UO4, KP7_UU2, KP7_KR1): Programming algorithms methods in massive parallel computing. Parallel computing using graphic cards in CUDA environment. Architecture of parallel computer systems. Numerical libraries. Parallel algorithms for solving systems of linear equations. Monte-Carlo calculations and simulations. Multidimensional numerical integrations.

Deep Learning (KP7_WG9, KP7_WG11, KP7_UW11, KP7_UW12, KP7_UW16, KP7_WK1): Definition of deep neural networks as a specific paradigm for machine learning, optimization and modeling. Definition of parameters and hyperparameters of models. Discussion of modular characteristics of deep models. Description of the most important and commonly used components of deep neural networks, including dense, convolutional, aggregation, folding, reduction, and residual layers. Nonlinear and normalizing components. Loss function and characteristics of the most commonly used loss functions. Learning by hetero- and auto-association. Implementation of deep neural network algorithms. Deep unsupervised learning models, in particular for cluster analysis. Generative models (GAN).

Security of Data and IT Systems (KP7_WG7, KP7_UW7, KP7_UW10, KP7_UW12, KP7_KR1): Data security digital systems and threats to information systems in the context of confidentiality, integrity and availability of information. Key aspects of cryptography. Theoretical and practical issues regarding data security in the context of the functioning of computer networks.

Advanced Algorithms and Data Structures (KP7_WG1, KP7_UU1, KP7_UK4, A7_UW3, KP7_UO4, KP7_UU2): Advanced graph algorithms: all-pairs shortest paths,

flow networks. String matching algorithms. Advanced data structures. Approximation algorithms. Parallel algorithms.

Management of IT Projects (KP7_WG10, KP7_WK2, KP7_UO3, KP7_UO4, KP7_UU2, KP7_KR1, KP7_KR2, KP7_UO1, KP7_UO2, KP7_UW10, KP7_UW11): life cycle, success rate and project plan. Task assignments and selection of team members. Management of: user requirements, risk and budget. Project schedule development. Tracking progress, Earned Value method. Documentation. Testing. Implementation of project. End user training. Warranty and Maintenance.

GROUP OF COURSES_ 3 Elective Courses

The symbol of the learning outcome: KP7_WG2, KP7_WG9, KP7_WG10, KP7_WK1, KP7_UW3, KP7_UW4, KP7_UW11, KP7_UW12, KP7_UW13, KP7_UW15, KP7_UO2, KP7_UO4, KP7_UU1, KP7_UU2, KP7_KR1

Analytic Methods in Computer Science (KP7_WG2, KP7_UW4, KP7_KR1)

COURSE_3/1A Analytical Methods in Computer Science: Linear space, projective space. Distance, non-Euclidean geometries. Pseudorandom number generators. Monte Carlo simulations. Creating functions and their application. Fourier transform. Fundamentals of cryptography. Classes are supported by the computer algebra system(CAS).

COURSE_3/1B Analytical Geometry in Computer Graphics: Finite dimensional linear spaces, linear transformations. Spherical geometry - complex numbers - quaternions. Projective space, cross-ratio, distances. Bernstein polynomials approximation. Examples in: PostScript (Ghostscript), gnuplot (supported by CAS).

Advanced Object-Oriented Programming (KP7_WG9, KP7_WG10, KP7_UW3, KP7_UW11, KP7_UO2)

COURSE_3/2A Advanced Object-Oriented Programming in C++: Advanced methods of object-oriented programming, STL.

COURSE_3/2B: Advanced Object-Oriented Programming in Java: a Reminder to the Object-Oriented paradigm. Reflection. Annotations - using existing and creating new ones. Creating client / server applications using RMI technology. Using code written in other languages - JNI.

COURSE_3/2C Advanced Object-Oriented Programming: Foundations of the object-oriented programming paradigm. Generic programming. Annotations. Reflective programming. Aspect-oriented programming. Use of code between different languages.

Multimedia Techniques and Systems (KP7_WG9, KP7_WG10, KP7_WK1, KP7_UW11, KP7_UW12, KP7_UW13, KP7_UW15, KP7_UO4, KP7_UU1, KP7_UU2, KP7_KR1)

COURSE_3/3A Multimedia Techniques: Multimedia as the form of communicating – applications of multimedia. Multimedia devices. Internet transmission of the image and sound in the real time – videoconferences. Compression of multimedia data. Entropy. Redundancy. Lossy compression – JPEG standard, MPEG Video, MPEG Audio. Lossless compression – Huffman method, structure of Huffman tree. Dictionary methods (LZ). Coding systems of the graphics, audio, video – formats. Digital recording

and processing of sound and sequence of video. Computer animations, „video capturing". Multimedia applications, tutorials.

COURSE_3/3B Adaptive Internet Multimedia Systems: The idea and structure of the system adapting itself to the needs of user. Individualization of the needs of a learner. Styles of learning and their classifications. Strategies of teaching and their computer representations. Selection of the strategy of teaching to the learning style. Tools for creating adaptive systems.

COURSE_3/3C Intelligent Multimedia Teaching systems: The idea and structure of the intelligent systems. Individualization of the needs of a learner. Styles of learning and their classifications. Strategies of teaching and their computer representations. Selection of the strategy of teaching to the learning style. Tools for creating intelligent systems.

SPECIALIZATION MODULE Internet and Mobile Technologies
GROUP OF COURSES_ 4A Specialization courses_1
The symbol of the learning outcome: KP7_WG7, KP7_WG9, KP7_WG10, KP7_WK1, KP7_UW1, KP7_UW7, KP7_UW11, KP7_UW12, KP7_UW13, KP7_UW14, KP7_UW15, KP7_UO2, KP7_UO4, KP7_UU2, KP7_UU3, KP7_KR1, KP7_KR2

Internet Applications Design (KP7_WG10, KP7_WK1, KP7_UW11, KP7_UW12, KP7_UW14, KP7_UW15, KP7_KR1): Website design based on Internet standards. Web usability. User-oriented design. Recommendations for the design of individual parts of the website: homepage, forms, links, etc. Web page navigation design. Advertising and web usability, typography, formatting and web usability, color and web usability. Web usability testing tools. Designing useful error handling. Designing forms. Methods and objectives of prototyping. Examples of mock-ups, prototypes and personae. Prototyping tools. Testing the usability and functionality of web pages. Design for different target groups (including disabled people). Designing multi-lingual pages. Designing applications for mobile devices.

Data Serialization Formats (KP7_WG10, KP7_WK1, KP7_UW11, KP7_UW15, KP7_UU2): description of the XML language. Well-formed and valid. DTD. XML supplementary languages. XML Schemas. Document Object Model. Description of the JSON language. JSON Schemas. Description of the YAML and TOML languages. Binary serialization formats.

Virtual Technologies and Containers (KP7_WG7, KP7_WG9, KP7_WK1, KP7_UW11, KP7_UW15, KP7_UO4, KP7_UU2, KP7_UU3, KP7_KR1):
To familiarize students with the concepts of virtualization and containerization technology. Installation and configuration of virtual machines and containers.

Mobile Technologies (KP7_WG9, KP7_WK1, KP7_UW12, KP7_UW13, KP7_UO4, KP7_UU2, KP7_KR1): Positioning and navigation of mobile users. Global positioning systems. Cellular systems. Wireless communication systems. Complex mobile processing problems. Wireless Local Area Networks. Mobile SDKs in various operating systems. Configuration and securing of wireless networks.

Internet Data Analysis (KP7_WK1, KP7_UW11, KP7_UW12, KP7_UW15, KP7_UO4, KP7_UU2, KP7_UU3, KP7_KR1, KP7_KR2): Types of data. Review of qualitative analyses. Analysis of quantitative data. Tests. Analysis

of competitiveness. Analyses of flow of users. New forms of analyses: social portals, mobile services and video contents. Software supporting internet data analysis.

Internet Frameworks (KP7_WG10, KP7_WK1, KP7_UW11, KP7_UW15, KP7_UO4): Introduction to internet frameworks. Network templates - Smarty and PHPTAL. Architectural design pattern MVC. Object-Relational Mapping ORM. Review of the most popular internet frameworks.

Mobile Applications Programming (KP7_WG9, KP7_WK1, KP7_UW1, KP7_UW11, KP7_UW15, KP7_UO4, KP7_UU2, KP7_KR1): Mobile operating systems, responsive web design in mobile applications, native mobile applications, and hybrid mobile applications. Features of mobile operating systems. Mobile networks, wireless LAN, NFC, Bluetooth, accelerometer, touch screen. Responsive mobile web applications address the mobile aspects of HTML5, CSS3, JavaScript, libraries, and front-end. Native mobile applications include APIs for operating systems such as Android and iOS

Network Programming (KP7_WG7, KP7_WK1, KP7_UW7, KP7_UW11, KP7_UW12, KP7_UO2, KP7_KR1): Implementing client-server types of applications in popular programming languages. Methods of implementing web services using selected tools and technologies. The working and configuration of a J2EE application server, e.g. Apache Tomcat. Programing Java servlets and Java Server Pages. Communication in heterogeneous networks using the SOAP standard. Definition and description of network services in the WSDL format. Practical application of main network programming technologies.

GROUP OF COURSES_ 5 Diploma Module

The symbol of the learning outcome: KP7_UK1, KP7_UK2, KP7_UK3, KP7_UK4, KP7_UU1, KP7_UU2, KP7_UU3, KP7_KR1, KP7_KK1

COURSE_5/1 and COURSE_5/2 (KP7_UK1, KP7_UK2, KP7_UK3, KP7_UK4, KP7_UU1, KP7_UU2, KP7_UU3, KP7_KR1, KP7_KK1)

M.Sc. Diploma Seminar 1: Students give talks related to the seminar topics and their master theses. They present their research results and elaborated possible examination questions. The seminar topics are adequate to the topics of students' master theses.

M.Sc. Diploma Seminar 2: Students give talks related to the seminar topics and their master theses. They present their research results. The seminar topics are adequate to the topics of students' master theses.

COURSE_5/3 and COURSE_5/4 (KP7_UU1, KP7_UK4, KP7_UO2, KP7_KR1)

M. Sc. Diploma Preparation Class 1: Directing the student to develop and write a thesis. Description justifying the purpose of the thesis, the description of the current state of knowledge related to the topic of work, searching for information in the literature, planning, conducting and critical assessment of experiments, presentation of research results of independent own work. Contents are selected subject to ongoing theses.

M. Sc. Diploma Preparation Class 2: Description justifying the purpose of the thesis and the description of the current state of knowledge related to the topic of work. Conducting and critical assessment of experiments, presentation of research results

of independent own work. Analysis and achieving the goals in the thesis. Contents are selected subject to ongoing theses.

Methods of verification and assessment of learning outcomes achieved by a student during the entire study cycle.

The following methods of verification of learning outcomes are applied, e.g., exams (written and/or oral), tests, projects evaluation, paper, report, problems solving, evaluation of laboratory work, activity evaluation, and self-evaluation of learning outcomes. The detailed information about methods of verification and assessment of learning outcomes is described in syllabuses.

Conditions of graduation and conferred professional title.

Graduating with the Master's Degree professional title requires completing all obligatory courses in the study programme, preparing a dissertation (master's) and passing a diploma examination (master's).

Explanation of the symbols

P6S_WG – *description symbol of the second degree PQF*

P – *practical profile* **A** – *general academic profile*	**K –** *field learning outcomes* **A –** *educational profile (A – general academic, P – practical)* **6 –** *educational level (6 - first degree study, **7** – second degree study and uniform master degree study)*
P6 or P7 – *PQF level (6 – first degree study, 7 – second degree study and uniform master degree study)* **S** -*specification typical of qualifications obtained in higher education*	
W – knowledge *(descriptive category)*	
G – *depth and extent*	
K – *context*	
U – skills *(descriptive category)*	
W – *use of knowledge*	
K – *communicating*	
O – *work organization*	
U – *learning*	
K – social competence *(descriptive category)*	
K – *critical evaluation*	
O – *responsibility*	
R – *professional role*	

Schedule of study programme implementation: computer science second degree
mode of study: full-time study
Institute of Computer Science

ECTS points acquired during the course:

ITEM	NAME OF A GROUP OF COURSES/NAME OF A COURSE	COURSE USOS CODE	Number of class hours	ECTS points	elective	with direct participation of academic teachers or other persons conducting classes and students	from the area of humanities or social sciences*	connected with scientific activity carried out at the university in the discipline or disciplines the field of study is assigned to, for the study of a general academic profile	developing practical skills, for the study of a practical profile
1	2	3		4	5	6	7	8	9
Group of Courses_ 1 General Education									
1	Intellectual Property Rights	420-IS2-1OWI-23CS	10	1		0,6			
2	Foreign language	420-IS2-1JN1-23/ 420-IS2-1JR1-23	30	2	2	1,5			
3	English for IT Professionals	420-IS2-1JAI-23CS	30	2		1,5			
4	Course to choose from humanities		10	2	2	0,6	2		
5	Course to choose from social sciences		25	3	3	1,2	3		
TOTAL			**105**	**10**	**7**	**5,4**	**5**		
Group of Courses_ 2 Main courses									
1	Modelling and Analysis of IT Systems	420-IS2-1MASI-23CS	30	3		1,7			
2	Advanced Databases	420-IS2-1ZBD-23CS	45	4		2,4		4	
3	Global Optimization	420-IS2-1OG-23CS	45	4		2,4		4	
4	Big data: processing and analysis of large data sets	420-IS2-1BDPA-23CS	45	4		2,4			
5	Introduction to Fuzzy Modelling and Analysis	420-IS2-1MSR-23CS	45	4		2,4		4	
6	Rule-based and Expert Systems	420-IS2-1SE-23CS	30	3		1,7		3	
7	Massively Parallel Computations	420-IS2-1MOR-23CS	45	4		2,4		4	
8	Deep Learning	420-IS2-1GUM-23CS	45	4		2,4		4	
9	Security of Data and IT Systems	420-IS2-2BDSI-23CS	45	4		2,4		2	
10	Advanced Algorithms and Data Structures	420-IS2-2ZASD-23CS	45	4		2,4		4	
11	Management of IT Projects	420-IS2-2ZPI-23CS	30	4		1,7			
TOTAL			**450**	**42**		**24,3**		**29**	
Group of Courses_ 3 Elective courses									
1	Analytic Methods in Computer Science	420-IS2-1MAI-23CS / 420-IS2-1GAGK-23CS	45	4	4	2,4			
2	Advanced Object-Oriented Programming	420-IS2-1ZPC-23CS/ 420-IS2-1ZPJ-23CS/ 420-IS2-1ZPO-23CS	30	4	4	1,7		4	
3	Multimedia Techniques and Systems	420-IS2-1TMUL-23CS/ 420-IS2-1AISM-23C / 420-IS2-1IMSU-23CS	30	4	4	1,7		2	
TOTAL			**105**	**12**	**12**	**5,8**		**6**	
Specialization module_ 1 (Internet and Mobile Technologies)									
Group of Courses_ 4A Specialization courses									
1	Internet Applications Design	420-IS2-1PAI-23CS	30	**3**		1,7		3	
2	Virtual Technologies and Containers	420-IS2-1TWK-23CS	30	**3**		1,7			
3	Data Serialization Formats	420-IS2-1TXP-23CS	45	4		2,4		4	
4	Mobile Technologies	420-IS2-1TMO-23CS	30	3		1,7			
5	Internet Data Analysis	420-IS2-2ADI-23CS	30	3		1,7		3	
6	Internet Frameworks	420-IS2-2PFI-23CS	45	4		2,4		4	
7	Mobile Applications Programming	420-IS2-2PAM-23CS	45	4		2,4		4	
8	Network Programming	420-IS2-2PSS-23CS	45	4		2,4		2	
TOTAL			**300**	**28**		**16,4**		**20**	
Group of Courses_ 5 Diploma Module									
	M.Sc. Diploma Seminar 1	420-IS2-2SM1-23CS	30	3	3	1,7		3	
	M.Sc. Diploma Seminar 2	420-IS2-2SM2-23CS	30	3	3	1,7		3	

Institute of Computer Science

<table>
<tr><td colspan="10" align="right">***ECTS points acquired during the course:***</td></tr>
<tr>
<th>ITEM</th>
<th>NAME OF A GROUP OF COURSES/NAME OF A COURSE</th>
<th>COURSE USOS CODE</th>
<th>Number of class hours</th>
<th>ECTS points</th>
<th>elective</th>
<th>with direct participation of academic teachers or other persons conducting classes and students</th>
<th>from the area of humanities or social sciences*</th>
<th>connected with scientific activity carried out at the university in the discipline or disciplines the field of study is assigned to, for the study of a general academic profile</th>
<th>developing practical skills, for the study of a practical profile</th>
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<tr><td>1</td><td>2</td><td>3</td><td></td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td>M. Sc. Diploma Preparation Class 1</td><td>420-IS2-2PM1-23CS</td><td>15</td><td>5</td><td>5</td><td>1,5</td><td></td><td>5</td><td></td></tr>
<tr><td></td><td>M. Sc. Diploma Preparation Class 2</td><td>420-IS2-2PM2-23CS</td><td>45</td><td>17</td><td>17</td><td>3,6</td><td></td><td>17</td><td></td></tr>
<tr><td>TOTAL</td><td></td><td></td><td>120</td><td>28</td><td>28</td><td>8,5</td><td></td><td>28</td><td></td></tr>
<tr><td>TOTAL</td><td></td><td></td><td>1080</td><td>120</td><td>47</td><td>60,4</td><td>5</td><td>83</td><td></td></tr>
</table>

* a number of ECTS points a student must obtain during classes from the area of humanities and social sciences, at least 5 ECTS points – with regard to the fields of study assigned to the disciplines in the areas other than humanities or social sciences respectively.	
Proportional (%) share of ECTS points in each discipline the field of study is assigned to, in a number of ECTS points necessary to complete the study, and indicating the prevailing discipline.	computer science - 100%
Proportional (%) share of ECTS points obtained during elective classes in a number of ECTS points necessary to complete the study, at least 30% of ECTS points necessary to complete the study.	39,17%
Proportional (%) share of ECTS points obtained during classes with direct participation of academic teachers or other persons conducting classes and students in a number of ECTS points necessary to complete the study, at least 50% of ECTS points necessary to complete the study.	50,33%
For the study of a general academic profile – proportional (%) share of ECTS points obtained during classes connected with scientific activity carried out at the university in the discipline or disciplines the field of study is assigned to, in a number of ECTS points necesary to complete the study, more than 50% of ECTS points necessary to complete the study.	69,17%
For the study of a practical profile – proportional (%) share of ECTS points obtained during classes developing practical skills in a number of ECTS points necessary to complete the study, more than 50% of ECTS points necessary to complete the study.	