## LEARNING OUTCOMES

## for the field of study

first degree study - general academic profile
Setting the field of study in discipline/scientific disciplines, which the learning outcomes refer to: computer science, mathematics, linguistics, law, philosophy, culture and religion science, economics and finance
Identification of the leading discipline: computer science

| Description symbol of the second degree Polish Qualification Framework (PQF) in the scope of computer science | DESCRIPTION OF THE SECOND DEGREE PQF | Symbol of the field outcome | DESCRIPTION OF THE FIELD <br> LEARNING OUTCOMES |
| :---: | :---: | :---: | :---: |
| KNOWLEDGE, a graduate is familiar with and understands: |  |  |  |
| P6S_WG | Scope and depth - completeness of the cognitive perspective and dependence <br> to an advanced degree - selected facts, objects and phenomena and their methods and theories explaining complex relationships between them, constituting basic general knowledge in the field of scientific or artistic disciplines forming theoretical foundations and selected issues related to detailed knowledge - appropriate for the study program | KA6_WG1 | basic knowledge about logic, discrete mathematics, algebra and mathematical analysis |
|  |  | KA6_WG2 | basic knowledge about statistics and probabilistic methods |
|  |  | KA6_WG3 | the idea of algorithm and the rules of designing and analyzing algorithms |
|  |  | KA6_WG4 | basic techniques and methods of programming, programming paradigms and languages |
|  |  | KA6_WG5 | the rules of collecting and saving data |
|  |  | KA6_WG6 | basic methods of approximate and exact calculations, understands the significance of error analysis in numerical calculations |
|  |  | KA6_WG7 | possibilities to use software for numerical calculations |
|  |  | KA6_WG8 | methodologies and tools allowing to create software in local, distributed and internet environment |
|  |  | KA6_WG9 | methods of network communication as well as rules of network safety |
|  |  | KA6_WG10 | basic rules of operating systems functioning |
|  |  | KA6_WG11 | basic concepts of artificial intelligence, representation and processing knowledge, human-computer interaction |
|  |  | KA6_WG12 | foundations of software engineering |
|  |  | KA6_WG13 | basic methods of technology and elements of distributed systems architecture, fundamental assumptions |



|  |  | KA6_UW11 | design and optimize a database in accordance with a specification, efficiently search for required information in an existing database, implement a database in a selected system of databases |
| :---: | :---: | :---: | :---: |
|  |  | KA6_UW12 | design a local area network, ensure safety while managing a local area network |
|  |  | KA6_UW13 | take advantage of possibilities of different operating systems in computer systems realizing different functions |
|  |  | KA6_UW14 | describe problems expressed in a natural language using the terminology of artificial intelligence |
|  |  | KA6_UW15 | use design patterns, APIs and tools supporting the process of creating, testing and debugging software |
|  |  | KA6_UW16 | use knowledge of the automata theory as well as formal languages to solve simple problems regarding humancomputer interaction, artificial intelligence, formulating algorithms and designing simple information systems |
|  |  | KA6_UW17 | create client-server type software |
|  |  | KA6_UW18 | use technologies of creating software working in the Internet |
|  |  | KA6_UW19 | use parallel calculations to increase the efficiency of algorithmic problem resolution, choose a suitable algorithm for a given model of parallel and distributed calculations |
|  |  | KA6_UW20 | implement the resolution of a problem requiring interaction between processes in distributed environment employing available software |
|  |  | KA6_UW21 | numerically model selected phenomena and simulate simple processes in a computational way, optimize numerical representations of phenomena and processes |
|  |  | KA6_UW22 | use selected computation models |
| P6S_UK | Communicating - receiving and creating statements, | KA6_UK1 | use the computer terminology in a foreign language |
|  | disseminating knowledge in the scientific community and using a foreign language | KA6_UK2 | prepare a study of computer science concepts and present them |
|  | communicate using specialized terminology <br> take part in a debate - present and evaluate various opinions and positions and discuss them | KA6_UK3 | independently devise the resolution of an assigned information technology task which is a borderline case of theory and practice as well as present the resolution and conclusions |
|  | use a foreign language at B2 level of the Common European Framework of Reference for Languages |  |  |
| P6S_UO | Work organization - planning and teamwork | KA6_U01 | work in a programming team to solve assigned problem |



## Explanation of the symbols

P6S_WG - description symbol of the second degree PQF

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

## KA6_WG1 - symbol of the field outcome

$\mathbf{K}$ - field learning outcomes
A - educational profile (A-general academic, $P$ - practical)
$\mathbf{6}$ - educational level (6-first degree study, 7 - second degree study and uniform master degree study)

W - knowledge (descriptive category)
$\mathbf{G}$ - depth and extent
$\mathbf{K}$ - context
$\mathbf{U}$ - skills (descriptive category)
$\mathbf{W}$ - use of knowledge
$\mathbf{K}$ - communicating
$\mathbf{O}$ - work organization
$\mathbf{U}$ - learning
K - social competence (descriptive category)
$\mathbf{K}$ - critical evaluation
$\mathbf{O}$ - responsibility
$\mathbf{R}$ - professional role

## I GENERAL INFORMATION

1. Setting the field of studies in discipline/scientific disciplines, which the learing outcomes refer to: computer science, mathematics, linguistics, law, philosophy, culture and religion science, economics and finance
2. Name of the field of study: Computer Science
3. Level of education: first degree studies
4. Educational profile: general academic
5. Form of study: full-time studies
6. A number of semesters: 6
7. Total number of ECTS points required to achieve the equivalent level of relevant qualifications: $\mathbf{1 8}$
8. Total number of teaching hours: 2210
9. Programme is effective from the academic year: 2019/2020
10. Programme adopted at the meeting of Faculty Board on 13.02.2019

## II. EDUCATION MODULES

|  | Field learing outcomes <br> Knowledge Skills <br> Social competence (symbols) | Teaching methods and verification | Courses/modules |  | QUANTITATIVE INDICATORS - ECTS points included in courses: |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  | in a foreign language (language classes) |  |  |
|  | KA6_WG1, KA6_UW2, KA6_UW4, KA6_UU1, KA6_KO1 | Teaching methods: Lecture and exercise classes, discussion, presentation, problem solving, individual exercises. <br> Assessment methods: exams (written and/or oral), tests, activity evaluation. | 1. Review of Mathematics | 3,0 | 1,0 |  | 3,0 |  |  |  |  |
|  |  |  | 2. Mathematical Analysis 1 | 4,0 | 2,0 |  | 2,0 |  |  |  |  |
|  |  |  | 3. Mathematical Analysis 2 | 6,0 | 2,0 |  | 2,0 |  |  |  |  |
|  |  |  | 4. Mathematical Analysis 3 | 3,0 | 2,0 |  | 2,0 |  |  |  |  |
|  |  |  | 5. Differential and Difference Methods | 2,0 | 1,0 |  | 1,0 |  |  |  |  |
|  |  |  | total | 18,0 | 8,0 | 0,0 | 10,0 | 0,0 | 0,0 | 0,0 | 0,0 |


|  | KA6_WG1, KA6_UW1, KA6_UW4, KA6_UU1, KA6_KK1 | Teaching methods: lecture and exercise classes. <br> Assesment methods: exams, tests, activity evaluation. | Linear Algebra with Analytical Geometry | 6,0 | 2,0 |  | 1,0 |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| total |  |  |  | 6,0 | 2,0 | 0,0 | 1,0 | 0,0 | 0,0 | 0,0 | 0,0 |
|  | KA6_WG1, KA6_UW4, KA6_UW5, KA6_UU1, KA6_KK1 | Teaching methods: lecture and exercise classes <br> Assesment methods: exams, tests, activity evaluation | Elements of Logic and Set Theory | 6,0 | 3,0 |  | 3,0 |  |  |  |  |
| total |  |  |  | 6,0 | 3,0 | 0,0 | 3,0 | 0,0 | 0,0 | 0,0 | 0,0 |
|  | KA6_WG1, KA6_WG3, KA6_UW2, KA6_UW4, KA6_UW6, KA6_UW8, KA6_UU1 | Teaching methods: lecture and exercise classes. <br> Assesment methods: exams, tests, activity evaluation. | 1. Discrete Mathematics | 5,0 | 2,0 | 2,0 | 5,0 |  |  |  |  |
|  |  |  | 2. Algorithms and Data Structures | 5,0 | 3,0 | 5,0 | 5,0 |  |  |  |  |
| total |  |  |  | 10,0 | 5,0 | 7,0 | 10,0 | 0,0 | 0,0 | 0,0 | 0,0 |





|  | KA6_WG2, KA6_UW3, KA6_UU1 | Teaching methods: lecture and exercise classes, homeworks. <br> Methods of verificationtests: exams, tests, activity evaluation. | Probability Methods and Statistics | 5,0 | 3,0 |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | total |  | 5,0 | 3,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
|  | KA6_WK2, | Teaching methods: lecture | 1.Humanities Course <br> Students choose one humanities course from a list approved by the Council responsible for the course of study | 2,0 | 1,0 |  |  | 2,0 |  |  | 2,0 |
|  | KA6_UU1, KA6_KR1, KA6_KO1 | projects. <br> Assesment methods: exams (written and/or oral), tests, | 2. Social Course choose one economy course from a list approved by the Council responsible for the course of study | 2,0 | 1,0 |  |  | 2,0 |  |  | 2,0 |
|  |  |  | 3. Computer and Information Ethics | 1,0 | 1,0 |  |  | 1,0 |  |  |  |
| total |  |  |  | 5,0 | 3,0 | 0,0 | 0,0 | 5,0 | 0,0 | 0,0 | 4,0 |
|  | KA6_WG11, KA6_UW14, KA6_UK3, KA6_UO2, KA6_UU1, KA6_KR1 | Teaching methods: lecture, laboratory and project classes. <br> Assesment methods: exams, tests, activity evaluation, project documentation evaluation. | Artificial Intelligence | 4,0 | 2,0 | 4,0 | 4,0 |  |  |  |  |
| total |  |  |  | 4,0 | 2,0 | 4,0 | 4,0 | 0,0 | 0,0 | 0,0 | 0,0 |


|  | KA6＿WG13， KA6＿UW19， KA6＿UW20， KA6＿UU1 | Teaching methods：lecture and laboratory classes． <br> Assesment methods：exams （written and／or oral）tests， activity evaluation． | Parallel and Distributed Programming | 4，0 | 2，0 | 4，0 | 4，0 |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | total | 4，0 | 2，0 | 4，0 | 4，0 | 0，0 | 0，0 | 0，0 | 0，0 |
|  | KA6＿WG1， KA6＿WG14， KA6＿UW5， KA6＿UW16， KA6＿UK3， KA6＿UW22， KA6＿UU1， KA6＿KK1 | Teaching methods：lecture and laboratory classes． <br> Assesment methods：exams， tests，activity evaluation． | Introduction to the Theory of Automata and Formal Languages | 4，0 | 3，0 | 4，0 | 4，0 |  |  |  |  |
|  |  |  | total | 4，0 | 3，0 | 4，0 | 4，0 | 0，0 | 0，0 | 0，0 | 0，0 |
| ベシ | KA6＿UK2， | Teaching methods： discussion，presentations． | 1．Seminar 1 | 2，0 | 1，0 | 2，0 |  |  |  |  | 2，0 |
|  |  | evaluation． | 2．Seminar 2 | 2，0 | 1，0 | 2，0 |  |  |  |  | 2，0 |
|  |  |  | total | 4，0 | 2，0 | 4，0 | 0，0 | 0，0 | 0，0 | 0，0 | 4，0 |
| $\infty$ | $\begin{aligned} & \text { KA6_UK2, } \\ & \text { KA6_UK3 } \end{aligned}$ | Teaching methods： presentations，individual work． | 1．Diploma Preparation Class 1 | 2，0 | 2，0 | 2，0 |  |  |  |  | 2，0 |
|  | KA6＿KO1 | Assesment methods： evaluation of diploma thesis preparation． | 2．Diploma Preparation Class 2 | 7，0 | 3，0 | 7，0 |  |  |  |  | 7，0 |
|  |  |  | total | 9，0 | 5，0 | 9，0 | 0，0 | 0，0 | 0，0 | 0，0 | 9，0 |


|  | KA6_UO2 | Teaching methods: exercises. <br> Assesment methods: activity evaluation. | Physical Education | 0,0 | 0,0 |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| total |  |  |  | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
|  | KA6_UK1 <br> KA6_UO2, <br> KA6_UU1, <br> KA6_KK1, <br> KA6_KO1 | Teaching methods: exercises, discussions, literature study, homeworks. <br> Assesment methods: exams (written and/or oral), tests, activity evaluation, selfassesment. | 1. English <br> 2. Russian <br> 3. German <br> 4. Polish (only for foreign students) A student chooses one of the above subjects | 12,0 | 4,0 |  |  |  | 12,0 |  | 12,0 |
|  |  |  |  | 12,0 | 4,0 | 0,0 | 0,0 | 0,0 | 12,0 | 0,0 | 12,0 |
|   <br> KA6_WG4,  <br> KA6_WG8,  <br> KA6_UW7,  <br> KA6_UW8,  <br> KA6_UU1,  <br> KA6_KO1  |  | Advanced Programming Methods: <br> 1. Component Programming <br> 2. .NET Programming <br> 3. Design Patterns <br> 4. Matlab Programming <br> 5. Internet Frameworks <br> A student chooses two of the above subjects or optional subjects with analogous learning outcomes and ECTS points from the offer approved by the Council responsible for the course of study |  | 8,0 | 4,0 | 8,0 | 8,0 |  |  |  | 8,0 |
|  | KA6_WG4, KA6_WG8, KA6_WG11, KA6_UW8, KA6_UO1, KA6_UK3, KA6_UO2, KA6_KK1 |  | Diagnostic and Control Systems: <br> 1. LabVIEW Programming <br> 2. Computer Measurement Systems <br> 3. Digital Signal Processing <br> 4. Medical Informatics <br> A student chooses one of the above subjects or optional subjects with analogous learning outcomes and ECTS points from the offer approved by the Council responsible for the course of study | 4,0 | 2,0 | 4,0 | 4,0 |  |  |  | 4,0 |



|  | KA6_WG5, KA6_WG9, KA6_WG10, KA6_WK1, KA6_UW11, KA6_UW12, KA6_UW13, KA6_UW17, KA6_UK1, KA6_UK2, KA6_UO1, KA6_UO2, KA6_UU1, KA6_KR1, KA6_KO1 | Teaching methods: presentations and demonstrations, practical exercises, group workshops. <br> Assesment methods: employer and supervisor evaluation, practice register evaluation. | Apprenticeships | 4,0 | 4,0 | 4,0 |  |  |  | 4,0 | 4,0 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | total | 4,0 | 4,0 | 4,0 | 0,0 | 0,0 | 0,0 | 4,0 | 4,0 |
|  |  | TOTAL NUMB | ER OF ECTS points for ALL MODULES | 183,0 | 95,0 | 123,0 | 109,0 | 5,0 | 12,0 | 4,0 | 57,0 |

* refers to the fields that are not assigned to the disciplines of humanities or social science


## III PROPORIIONAL INDICATORS (percentage)

| 1. Percentage share of ECTS points for the classes that require direct participation of teachers or other people conducting classes: | 51,91\% |
| :---: | :---: |
| 2. Percentage share of ECTS points earned for elective modules (min. 30\%): | 31,15\% |
| 3. Percentage share of ECTS points earned for the classes conducted in a foreign language (in a total number of ECTS points envisaged by the study programme): | 100,00\% |
| 4. Percentage share of ECTS points earned for the modules of classes shaping practical skills for practical educational profiles (above $50 \%$ ): | not applicable |
| 5. Percentage share of ECTS points earned for the modules of classes connected with scientific activity conducted at the university in discipline/disciplines, to which the field of study is assigned for general academic profile (above $50 \%$ ): | 59,56\% |


| 6. Percentage shares of individual (all) discipline of science, which the study programme refers to: | computer science | 69,67\% |
| :---: | :---: | :---: |
|  | mathematics | 20,49\% |
|  | linguistics | 6,56\% |
|  | law | 0,55\% |
|  | philosophy | 0,55\% |
|  | culture and religion science | 1,09\% |
|  | economics and finance | 1,09\% |

IV. CONDITIONS OF GRADUATION AND CONFERRED PROFESSIONAL TITLE

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

## STUDY PROGRAMME - Part B

1. Name of the field of study: Computer Science
2. Level of education: first degree studies
3. Educational profile: general academic

## MODULES' PROGRAMME CONTENT

## MK_1 Mathematical Analysis:

MK_1/1 Review of Mathematics: Systematize math knowledge acquired in secondary school. Bridge the gap between the „school math knowledge" and math knowledge required for academic level mathematics.

MK_1/2 Mathematical Analysis 1: Mathematical logic - elements, elements of set theory. Relations, functions and their properties. Numerical sequences, properties, limits. Numerical series, their properties and convergence.

MK_1/3 Mathematical Analysis 2: Limit of one variable function. Actions on functions and their boundaries. Asymptote functions. Continuity of function. Derivative of the function of one variable and its properties. Derivative of the inverse and composite function. Differential of a function. Extrema of functions of one variable. L'Hospital's rule. Derivatives of higher orders. Taylor series. Power series. Sequences and series functions. Antiderivative indefinite integral. Integration of rational, irrational and trigonometric functions. The Riemann integral. Improper integral.

MK_1/4 Mathematical Analysis 3: Topological properties, metric space. Function of several variables, domain, limits, graphs of two variable functions. Partial derivatives. Symmetry of second derivatives. Directional derivative, gradient. Implicit differentiation. Second partial derivative test. Jacobian. Polar coordinate system. Double, triple integral over a normal domain and its applications.

MK_1/5 Differential and Difference Methods: Types of ordinary differential equations, methods of solving differential equations, certain applications of first-order differential equations, difference equations.

## MK_2 Algebra:

Linear Algebra with Analytical Geometry: Fundamental algebraic structures: groups, rings and fields; the complex number field; the polynomial ring over an arbitrary ring; formulation of problems in matrix-vector terms and operations on matrices (the inverse of matrices, the rank of matrices); solving systems of linear equations using different methods; checking linear independence and determination a base of vector space; using notions of analytic geometry.

## MK_3 Logic and Set Theory:

Elements of Logic and Set Theory: Expressing thoughts formally and correctly, reasoning using logical tools. Fundamental notions and methods necessary to understand more advanced mathematical theories. Formally constructing and modelling mathematical objects on settheoretical grounds.

## MK_4 Design and Analysis of Algorithms:

MK_4/1 Discrete Mathematics: Induction and recursion, the basics of combinatorics, basic techniques of counting, the basics of graph theory, the basics of number theory.

MK_4/2 Algorithms and Data Structures: Basic data structures (lists, stacks, queues, hash tables, trees, graphs), algorithms (graph algorithms, pattern matching in strings) and different methods of their design ("divide and conquer", dynamic programming, greedy methods) and also estimation of their complexity.

## MK_5 Programming:

MK_5/1 Introduction to Structured Programming: Information processing in computer (representation of information, information processing on machine-level and high-level languages). Programming in C.

MK_5/2 Python Programming: Python Environment. Programming paradigms (structural, object-oriented, functional) in the context of Python. Elements of network programming. The designing and implementation of programs using selected packages and modules. The course includes elements of processing and analysis of big data sets.

MK_5/3 Introduction to Object-Oriented Programming: Familiarize the students with the basic concepts and techniques of object-oriented programming on the example of C++. Practice the most important object-oriented techniques. Teach design, implementation and analysis of programs in the object-oriented paradigm.

MK_5/4 Advanced Programming: Introduction to the Java language. Object oriented programming: inheritance, polymorphism. Exceptions - defining and using. Generic programming: parametrized types, collections, comparators, iterators, algorithms. Graphical user interfaces. Event programming.

## MK_6 Programming Environments:

MK_6/1 Graphics and Human-Computer Communication: Programming in a graphical environment. Analysis of the human-computer interaction on the example of 2D games programming. Digital image representation and processing: intensity transformations, blending, filtering, enhancement by histogram modification, geometric transformations. The basics of 3D modelling.

MK_6/2 Graphical User Interface Programming: Basic mechanisms of programming in the Windows operating system. Functionality of the Windows API, Windows Forms library
contained in the. NET Framework and WPF engine to create user interfaces. General principles of designing a graphical user interface with regard to ergonomics and analysis of the needs of potential users.

## MK_7 Technical Aspects of Informatics:

MK_7/1 Computer System Architecture: Digital technology and digital systems, Machine representation of data and execution of arithmetic operations, Computer organization on the level of assembler, Organization and storage systems architecture, Interfaces and communication, organization of the CPU, Multiprocessing and alternative architectures

MK_7/2 Operating Systems: Basic use, configuration and administration of various operating systems. Solving basic problems concerning a multitasking operating system environment and using all its resources, i.e. CPU, memory, disks.

MK_7/3 Network Technologies: Construction and operation of computer networks. OSI and TCP / IP - the protocols and features, IP addressing, routing, switching, Wide Area Networks (WAN), Virtual Private Networks (VPN).

## MK_8 Professional and legal issues in informatics:

MK_8/1 Health, Safety and Ergonomics: General principles of safety and ergonomics with a special focus on health and safety regulations for computer workstation and ergonomic principles in the design of the computer workstation.

MK_8/2 Intellectual Property Rights: Copyrights and related rights; observance of intellectual property including the computer programs.

## MK_9 Numerical Methods:

Computational Methods: Calculation of errors of arithmetic operations. Interpolation and approximation methods. Numerical integration (quadratures with fixed nodes, Gauss quadratures). Approximated solving of systems of linear equations. Solving of nonlinear equations with one unknown.

## MK_10 Databases and Applications:

MK_10/1 Databases: Introduction. Relational model. Relational algebra. SQL language. Designing relational databases. Normalization. Normal forms. Conceptual design. Entity relationship diagram. Logical design. Physical design. Basic file structures. Indexes. Transactions. Concurrency. Optimization.

MK_10/2 Internet Programming: Basic Internet programming techniques, languages, tools and standards.

## MK_11 Software engineering:

MK_11/1 Software Engineering 1: The typical software lifecycle phases, principles of systems design by the object method, software development tools, software requirements
specification, testing rules of software and software configuration management, project planning and software development process management.

MK_11/2 Software Engineering 2: The rules of development of complex systems with particular consideration of implementation as phase. The four main programming paradigms (imperative, functional, object-oriented and logic) as a fundamental style of computer programming, as well the basic software design patterns will be discussed.

MK_11/3 Team Project: Creating simple applications in a small team. Choosing a suitable model of creating an application. Dividing tasks for each person in a group. Creating a work plan. Documenting and testing applications.

## MK_12 Probabilistic Methods and Statistics:

Probability methods and statistics: Random variable, The probability of discrete and continuous, Probability distributions, Expected values, Variance, Standard deviation, Stochastic processes, Sampling, The problem of estimation, Testing statistical hypotheses, Correlation and regression, Computer methods of statistics.

## MK_13 Humanities and Social Courses:

MK_13/1 Humanities Course: Students choose one humanities course from a list approved by the Faculty Board

MK_13/2 Economy Course: Students choose one economy course from a list approved by the Faculty Board

MK_13/3 Computer and Information Ethics: The genesis of computer and information ethics. Intellectual property. Privacy and anonymity. Professional responsibility of computer scientists, codes of conduct for computer professionals, and computer crimes.

## MK_14 Artificial intelligence:

Artificial Intelligence: Rough sets. Fuzzy sets. Artificial neural networks. Classification and clustering algorithms. Search methods. Evolutionary algorithms. Practical part: Application selected classification/clustering algorithms to data sets and reporting on the results.

## MK_15 Parallel and Distributed Programming:

Parallel and Distributed Programming: Characteristics of parallel and distributed programming. Architectures of computers. Models and algorithms of calculations. Programming with shared memory, OpenMP interface. Programming with message-passing, MPI library. GPGPU graphics cards programming elements.

## MK_16 Theoretical Foundations of Informatics:

Introduction to the Theory of Automata and Formal Languages: Basic issues: the language and grammar, regular grammars, context-free grammars, context-sensitive grammars, finite
automata, pushdown automata, Turing machines, non-determinism, Chomsky hierarchy, characterization of the problems due to the undecidability and complexity.

## MK_17 Seminar:

MK_17/1 Seminar 1: Presentation of students' research results achieved during preparation of their diploma theses, improvement of skills of communicative transfer of knowledge, presentation of issues from the list of exam topics. The range of presentation topics corresponds to the topics of prepared theses.

MK_17/1 Seminar 2: Presentation of students' research results achieved during preparation of their diploma theses, improvement of skills of communicative transfer of knowledge, presentation of issues from the list of exam topics. The range of presentation topics corresponds to the topics of prepared theses.

## MK_18 Diploma preparation:

MK_18/1 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, also in foreign languages, planning, conducting and critical assessment of experiments, presentation of research results of independent own work. Contents are selected subject to ongoing theses.

MK_18/2 Diploma Preparation Class 2: 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, also in foreign languages, planning, conducting and critical assessment of experiments, presentation of research results of independent own work. Contents are selected subject to ongoing theses.

## MK_19 Physical Education:

Physical Education: Safety precautions for physical education classes, the rules of use of the sports facility. Learning the basic technical and tactical elements. Educating students to care for their physical condition and supporting the development of social competence in group cooperation.

## MK_20 Foreign Languages:

MK_20/1 English: Everyday 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).

MK_20/2 Russian: Everyday 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).

MK_20/3 German: Everyday 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).

MK_20/4 Polish: Everyday 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).

## MK_21 Elective Courses:

MK_21A Advanced Programming Methods; to choose among:
MK_21A/1 Component Programming: Design multilayer component-based applications implemented on J2EE platform. Architecture of J2EE application. Model-View-Controller (MVC) design pattern. Enterprise JavaBeans (EJB). Types of EJB components. Java database connectivity interface (JDBC). Servlets in J2EE application. Session management. Security issues.

MK_21A/2 .NET Programming: To provide foundations and characteristics of .NET platform and its derivatives. Implementation of programs for .NET using WPF engine.

MK_21A/3 Design Patterns: Genesis of design patterns. Uses of design patterns and examples of their use in practice. Recognize the applicability of design patterns in the projects. Correct design and implementation of projects using design patterns on the example of Java.

MK_21A/4 Matlab Programming: Matlab Environment. The designing and implementation of programs using embedded Matlab function and selected Matlab toolboxes, in particularly to solve 'Big Data' problems. Parallel computing.

MK_21A/5 Internet Frameworks: The essence and purpose of web frameworks. Overview of the most popular frameworks and online libraries.

MK_21B Diagnostic and Control Systems; to choose among:
MK_21B/1 LabVIEW Programming: The basics of graphical programming in LabVIEW. Creating simple programs in G language. Operating and modifying selected applications in the LabVIEW environment. Creating applications which can control selected electronic devices. Creating data acquisition applications and data visualization applications.

MK_21B/2 Computer Measurement Systems: Configuration and structure of measurement system. Measurement interfaces. Digital-to-analogue and analogue-to-digital converters. Signal processing. ELVIS II + educational platform. Programming elements in LabVIEW. Virtual and wireless measurement systems.

MK_21B/3 Digital Signal Processing: Different methods of signal analysis and practical signal analysis in MATLAB (application of digital signal processing methods for artificially generated signals and biomedical signals ECG and EEG).

MK_21B/4 Medical Informatics: Various methods of signal and image analysis, computer systems and software at different levels of health care, telemedicine and medicine on the Internet and the possibility of practical applications.

MK_21C Knowledge Representation and Processing; to choose among:
MK_21C/1 Constructive Methods in Computer Science: The basics of the Mizar proof verification system to enable verification of various reasoning examples.

MK_21C/2 Functional Programming: Introduction to lambda calculus, acquaintance with functional programming paradigm, acquaintance with selected functional language.

MK_21C/3 Logic Programming: Introduction to logic programming paradigm, acquaintance with Prolog.

MK_21C/4 LaTeX Typesetting System: Various document classes. Fonts. Environments. Tables. Graphics. Definitions and redefinitions. Mathematical mode. Various indexes. Creating of classes and packages. Dynamic presentations.

MK_21D Modelling and Simulation; to choose among:
MK_21D/1 Computer modelling and simulation methods: The modelling phases and the methods of creating models of selected systems and their analysis using computer simulation. Creating mathematical models of systems, creating computer models using selected programming environments and conducting computer simulation of the systems' performance.

MK_21D/2 Optimization Methods: The formulation of the goal function with constraints and without constraints. The necessary and sufficient conditions of extremum. Searching extremum of goal function by numerical methods. Gradient methods. Nonlinear optimization with constraints. Square programming. Simplex method for linear optimization.

MK_21D/3 Computer Statistics: The purpose of the course is to give the student a good overview of statistical techniques that have been developed during the last years due to increasing computer capacity. Using the statistical software R.

MK_21E Applied Computer Science; to choose among:
MK_21E/1 Bioinformatics: Introduction to molecular biology. Bimolecular sequence analysis. Biological databases. Introduction to structural bioinformatics. Introduction to R and Python and their applications in bioinformatics. Biopython and Bioconductor libraries. Implementation of bioinformatics workflows in R and Python.

MK_21E/2 Digital Image Processing: Acquisition of digital images - equipment, sampling, quantization, colour representation. Methods of digital image processing: arithmetic
operations, image enhancement, noise removal, edge detection, tresholding and morphological methods. Analysis of digital images: segmentation, background generation, foreground object detection, labelling and shape coefficients. Image processing in the frequency domain, the 2D Fourier Transform. Vision systems: standards, equipment and acceleration methods.

MK_21E/3 Computer Methods in Technology: Basic concepts of computer modelling and simulation. Analysis of mathematical models. Boundary problems. Finite Difference Method (FDM). Boundary element method (BEM). Finite element method (FEM). Parametric integral equation system (PIES) as a computer method for 2D and 3D problems.

MK_21E/4 Machine Translation in Grammatical Framework: The possibilities of machine translation based on grammatical analysis with examples of its applications.

MK_21E/5 Graphics Cards Programming: Practical applications of massively parallel graphic cards for scientific computations. Programming model for massively parallel processors. Applications in machine learning algorithms.

## MK_22 Apprenticeships:

Apprenticeships: Configuration of computer equipment, work on different operating systems (eg. Windows, Linux). Understanding the infrastructure of computer networks of the enterprise as well as its data protection, processing and archiving programs. Knowledge of the basic principles of teamwork, working together on projects in the enterprise software development teams.


MODULE 6 (Programming Environments)


MODULE 8 (Professional and Legal Issues in Informatics)


|  |  |  |  |  |  | Number of classes |  |  |  |  |  |  |  |  |  |  |  |  |  | Ilyear |  |  |  |  |  | 5 sem． |  |  |  |  |  |
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| Item | MODULE NAME／COURSE NAME | USOS course code | ECTS |  |  |  |  |  |  |  |  |  |  |  |  | $\begin{aligned} & \stackrel{\rightharpoonup}{\mathrm{E}} \\ & \stackrel{\rightharpoonup}{2} \end{aligned}$ | $\begin{aligned} & \stackrel{y}{w} \\ & \stackrel{y}{5} \\ & \stackrel{y}{4} \\ & \hline \end{aligned}$ |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | $\underbrace{}_{\substack{4 \\ \hline}}$ |   |  | sem． |
| MODULE 9 （Numerical Methods） |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | Computational Methods | 0600－CS1－2MOB | 4 | 4 |  | 60 | 30 |  |  |  |  | 30 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 30 | ｜ 30 | 4 |  |  |  |  |  |  |
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| 1 | Databases | 0600－CS1－2BD | 5 | 3 |  | 60 | 30 |  |  | 30 |  |  |  |  |  |  |  |  |  | 30 | 30 | 5 |  |  |  |  |  |  |  |  |  |
| 2 | Internet Programming | 0600－CS1－2PIN | 4 |  | 4 | 60 | 30 |  |  | 30 |  |  |  |  |  |  |  |  |  |  |  |  | 30 | 30 | 4 |  |  |  |  |  |  |
|  | TOTAL |  | 9 |  |  | 120 | 60 |  |  | 60 |  |  |  |  |  |  |  |  |  | 30 | 30 | 5 | 30 | 30 | 4 |  |  |  |  |  |  |
| MODULE 11（Sottware Engineering） |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | Software Engineering 1 | 0600－CS1－2101 | 2 |  | 4 | 30 | 30 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 30 |  | 2 |  |  |  |  |  |  |
| 2 | Software Engineering 2 | 0600－CS1－3102 | 4 | 5 |  | 60 | 15 |  |  | 45 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 15 | 45 | 4 |  |  |  |
| 3 | Team Project | 0600－CS1－3PZE | 5 |  | 6 | 30 |  |  |  | 30 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 30 | 5 |
|  | TOTAL |  | 11 |  |  | 120 | 45 |  |  | 75 |  |  |  |  |  |  |  |  |  |  |  |  | 30 |  | 2 | 15 | 45 | 4 |  | 30 | 5 |
| MODULE 12（Probabilistic Methods and Statistics） |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | Probabilistic Methods and Statistics | 0600－CS1－2PST | 5 | 4 |  | 75 | 30 | 30｜ |  | 15 |  |  |  |  |  |  |  |  |  |  |  |  | 30 | 45 | 5 |  |  |  |  |  |  |
| MODULE 13（Humanities and Social Courses） |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| 1 | Humanities Course |  | 2 |  | 2 | 30 | 30 |  |  |  |  |  |  |  |  |  | 30 |  | 2 |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 | Social Course |  | 2 |  | 3 | 30 | 15 | 15 |  |  |  |  |  |  |  |  |  |  |  | 15 | 15 | 2 |  |  |  |  |  |  |  |  |  |
| 3 | Computer and Information Ethics | 0600－CS1－3EI | 1 |  | 5 | 15 | 15 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 15 |  | 1 |  |  |  |
|  | TOTAL |  | 5 |  |  | 75 | 60 | 15 |  |  |  |  |  |  |  |  | 30 |  | 2 | 15 | 15 | 2 |  |  |  | 15 |  | 1 |  |  |  |
| MODULE 14（Arrificial Intelligence） |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | Artificial Intelligence | 0600－CS1－3SZI | 4 | 6 |  | 60 | 30 |  |  | 30 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 3013 | 30 |  |
| MODULE 15 （Parallel and Distributed Programming） |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| 1 | Parallel and Distributed Programming | 0600－CS1－3PRR | 4 |  | 5 | 60 | 30 |  |  | 30 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 30 | ｜ 30 | 4 |  |  |  |
| MODULE 16 （Theoretical Foundations of Informatics） |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| 1 | Introduction to the Theory of Automata and Formal Lanquages | 0600－CS1－3TAJF | 4 | 5 |  | 60 | 30 |  |  | 30 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 30 | 30 | 4 |  |  |  |
|  | TOTAL |  | 4 |  |  | 60 | 30 |  |  | 30 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 30 | 30 | 4 |  |  |  |
| MODULE 17 （Seminar） |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | Seminar 1 | 0600－CS1－3SD1 | 2 |  | 5 | 30 |  |  |  |  |  | 30 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 30 | 2 |  |  |  |
| 2 | Seminar 2 | 0600－CS1－3SD2 | 2 |  | 6 | 30 |  |  |  |  |  | 30 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 30 | 2 |
|  | TOTAL |  | 4 |  |  | 60 |  |  |  |  |  | 60 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 30 | 2 |  | 30 | 2 |
| MODULE 18 （Diploma Preparation） |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | Diploma Preparation Class 1 | 0600－CS1－3PD1 | 2 |  | 5 | 15 |  |  |  | 15 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 15 | 2 |  |  |  |
| 2 | Diploma Preparation Class 2 | 0600－CS1－3PD2 | 7 |  | 6 | 45 |  |  |  | 45 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 45 | 7 |
|  | TOTAL |  | － |  |  | 60 |  |  |  | 60 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 15 | 2 |  | 45 | 7 |
| MODULE 19 （Physical Education） |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | Physical Education 1 | 0600－CS1－1WF1 |  |  | 1 | 30 |  | 30 |  |  |  |  |  |  | 30 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 | Physical Education 2 | 0600－CS1－1WF2 |  |  | 2 | 30 |  | 30 |  |  |  |  |  |  |  |  |  | 30 |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | TOTAL |  |  |  |  | 60 |  | 60 |  |  |  |  |  |  | 30 |  |  | 30 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| MODULE 20（Foreign Languages） |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | Foreign Language 1 |  | 3 |  | ， | 30 |  |  |  |  | 30 |  |  |  | 30 | 3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 | Foreign Language 2 |  | 3 |  | 2 | 30 |  |  |  |  | 30 |  |  |  |  |  |  | 30 | 3 |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 | Foreign Language 3 |  | 3 |  | 3 | 30 |  |  |  |  | 30 |  |  |  |  |  |  |  |  |  | 30 | 3 |  |  |  |  |  |  |  |  |  |
| 4 | Foreign Language 4 |  | 3 | 4 |  | 30 |  |  |  |  | 30 |  |  |  |  |  |  |  |  |  |  |  |  | 30 | 3 |  |  |  |  |  |  |
| TOTAL |  |  | 12 |  |  | 120 |  |  |  |  | 120 |  |  |  | 30 | 3 |  | 30 | 3 |  | 30 | 3 |  | 30 | 3 |  |  |  |  |  |  |



