Warsaw School of Computer Science

Syllabus

COURSE OF STUDY: COMPUTER SCIENCE
SECOND CYCLE STUDIES OF GENERAL ACADEMIC PROFILE

I. GENERAL INFORMATION ABOUT STUDIES

1. Course of study: **COMPUTER SCIENCE**
2. Level of education: **second cycle studies (Master)**
3. Education area: **technical science**
4. Education profile: **general academic profile**
5. Mode of studies: **school-based**
6. Duration: **4 semesters**
7. Graduate title: **Master**
8. Specialization**: PROJECT MANAGEMENT**
9. Entry requirements: first cycle studies (Bachelor) degree in computer science or related field
10. Admission checklist: free entry for first cycle undergradutes with degree in computer science
    Qualifying examination for undergradutes with degrees in other areas of education
11. Main syllabus assumptions and general learning objectives in the field of computer science – second cycle studies (Master):

The concept of education at Warsaw School of Computer Science describes in particular assumptions concerning (1) the goals of studies, content, outcomes and methods of verifying learning outcomes as well as the degree to which they meet internal and external education stakeholders, the mission and strategy of the School, (2) conditions to be met by the School in order to ensure effective realization of goals and outcomes assumed in the syllabus(3) manner in which the educational process is organized and managed and (4) the method of verifying learning outcomes (internal quality assurance system).

The concept of education at Warsaw School of Computer Science places special emphasis on practice-oriented education achieved through frequent communication and developing direct relations with employers during all stages of preparation and realization of the concept of education, developing individual interests among students through diversified educational offer,

internationalization of students' education and employing graduates, using modern information technology including e-learning as well as partner participation of internal stakeholders (students) and external, stakeholders (other academic centers), lifelong learning for high school students, academics from other universities and graduates and other individuals interested in gaining additional competence within information and communication technology.

Principles concerning education and their application in the educational concept of Warsaw School of Computer Science

Adjusting the content, methods and conditions of education to the needs, abilities and aptitudes of internal stakeholders (students) is realized on the basis of experiences gained at an educational stage that comes before academic stage of education, during studies and after graduation as results from surveys on graduates' post-academic careers.

SPECIFICATION OF LEARNING OUTCOMES FOR THIS AREA OF EDUCATION

Table of references between field-related and area-related learning outcomes

Course of study: computer science
Level of education: second cycle (Master) studies
Educational profile: general academic profile
Mode of studies: school-based
Graduate title: Master of computer science
Assigned area or areas of study: area of technical science

KNOWLEDGE
Student has theoretical knowledge necessary to analyze complex computer science problems
Student has an extensive and advanced knowledge of information technology techniques within designing and analyzing algorithms
Student has systemized knowledge of key issues in computer science.
Student has extensive and advanced knowledge of selected issues in computer science (one or few selected areas of computer science) concerning:

– advanced algorithms and programming methods, – operating systems, – network technologies, – foundations of graphics and multimedia, – databases, – embedded systems, – foundations of digital security, – elements in administering and managing IT and ICT systems, – modeling IT systems, – ICT foundations, – data analysis and processing, – artificial intelligence, – selected IT applications.
Student has a theoretically founded detailed knowledge of selected issues in one or few areas of computer science, concerning: – data transmission systems, – Internet and e-learning technologies, – concurrent and distributed programming, – graphics and multimedia, – data warehouses, – mobile systems, – digital security, – administering and managing IT and ICT systems, – software engineering, – selected IT applications.
Student has an up-to-date knowledge of developmental trends in computer science.
Student knows basic techniques to design IT systems.
Student has basic knowledge in management, quality management and self-employment management.
Student knows basic concepts of copyrights.
Student knows general principles of creating and developing forms of individual enterprise incorporating knowledge of computer science.
Student knows how to acquire information from literature, databases and other sources; Student knows how to integrate acquired information as well as how to interpret and evaluate this information critically. Student also knows how to draw conclusions and formulate and exhaustively justify his/her opinions.
Student is able to work both independently and as a team member ; Student is able to evaluate time consumption of tasks; He or she is also able to

manage a small team in a manner ensuring task completion before the deadlines.
Student is able to formulate detailed documentation of results of the experiment or a development task or a research project; Student is also able to develop a study describing results.
Student is able to prepare and give a presentation on the subject of a development task or a research project execution as well as lead a discussion concerning the given presentation.
Student uses English language at a level sufficient for communication, discussing professional matters and for reading professional literature with comprehension, as well as for preparing and giving a presentation on the subject of development or research project.
Student is able to establish one's own further educational path.
Student is able to research implemented algorithms and systems in an experimental manner.
Student is able to apply the mathematical knowledge in analyzing and optimizing IT solutions.
Student is able to process and interpret the results of experiments on analyzed algorithms.
Student is able to apply theoretical knowledge obtained during studies to implement IT systems.
Student is able to formulate hypotheses within the area of computer science.
Student is able to evaluate usefulness of new theoretical solutions and new IT tools.
Student is qualified to undertake work in IT companies.
Student is able to make an initial economic analysis of an IT enterprise.
Student is able to critically evaluate existent IT systems.
Student is able to offer improvements to existent IT systems.
Student is able to design complex IT systems with regards to non-technical aspects.
Student is able to observe limitations in the existent IT tools.
Student is able to design a complex IT system (object) according to a given specification, prepare a schedule of its implementation as well as implement the project (at least partially) using appropriate methods, techniques and tools (adjusting existent solutions or developing new solutions)
Student understands the need of continued education; Student is able to inspire and organize the learning process for others.
Student is aware and understands the importance of non-technical aspects and consequences of an IT specialist's business activity, including its impact on environment and responsibility for his/her decisions.
Student is able to cooperate and work in a team by accepting various roles within that team.

Student is able to define priorities that will serve the realization of a task chosen by himself/herself or other people.
Student is able to identify and solve issues connected with one's own professional work.
Student is able to think and act in a creative and innovative way.
Student is aware of social competences of an IT graduate.

II. Professional profile of a second cycle studies graduate in the area of computer science and specialization in project management

Level of education: ***Second cycle studies;*** ***Course of study:*** ***Computer Science (Master)***

Specialization: ***Project Management***

Second cycle studies (Master) graduate in the area of computer science has a general IT knowledge of all subjects typical for second level studies and is proficient within his/her own specialization. The graduate is also able to:

- to solve IT problems independently – prepare, implement and verify IT projects, also in unusual situations such as making opinions on the basis of incomplete or limited information while at the same time observing legal and ethical rules,
- to use IT tools and advanced programming,
- to self-educate and improve his/her knowledge in a fast-changing IT reality; to understand the need of lifelong education to improve one's professional, personal and social competencies,
- to start work in IT companies, public and local administration and be ready to start work within the educational sector (after gaining teaching qualifications),
- mange teamwork,
- to start research and academic work, both individual and as a team member as well as to start third-cycle (doctoral) studies.

Second cycle (Master) graduate in the area of computer science and specialization in ***Project Management*** has professional competencies within:

- ⇨ object, subject and designing process identification and modeling
- ⇨ classification, identification and evaluation of the complexity of projects
- ⇨ modeling and evaluation of the project management cycle
- ⇨ evaluating projects according to economic, technical and organizational indexes
- ⇨ evaluating projects according to functionality and quality indexes
- ⇨ time and cost optimization of project enterprise
- ⇨ risk estimating, planning and monitoring within the whole project cycle
- ⇨ multi-aspect selection of project management methodology
- ⇨ identification and selection of computer aided design systems and project management systems

- ⇨ modeling or selection of project environment
- ⇨ preparation of design patterns and project standards
- ⇨ supervising or participating in teams controlling the process of design, documentation and report making.

Graduates of ***Project Management*** specialization are able to work in the following professional positions:

- organizer of project enterprises within a company
- system analyst of innovative project enterprises
- project environment analyst
- project evaluation and validation specialist
- project manager for medium complexity project or unit manager in complex projects.
- designer of IT applications in a company.

III. Specification of learning outcomes for particular subjects and methods of assessment

Learning content

1. INFORMATION SYSTEM MODELING AND ANALYSIS (10 ECTS)

LEARNING OUTCOMES
Semester 1 1. Foundations of system analysis. Terms, methods, analysis and assessment techniques. Foundations of system analysis. 2. System analysis of the objects of computerization: goals, functions, requirements and limitations. Formulating project tasks for the needs of information systems engineering. 3. Decision making scenarios in information systems engineering. Multi-criterial (multi-attribute) comparative analysis of variants in system solutions in managing information system design. 4. Methodological foundations of information systems modeling. Classification and typology of system models. Formal methods. 5. Methods of modeling system structures. 6. Methods of modeling system dynamics. 7. Structural methods of analysis and information systems design. Basic tools of structural methods. 8. Object oriented methodologies of analysis and information system designing. Basic tools. 9. Comparative analysis of methodologies, modeling and designing computer systems. Advantages, disadvantages, development prospects. 10.

Semester 2

1. Introduction to object orientation. Object-oriented thinking in modeling information systems.
2. Basic terms in object-oriented programming. Objects, classes, encapsulation, inheritance.
3. Foundations of modeling in UML. Use cases, classes, interactions, states and activity diagrams.
4. Systems, models and views. Types of data, classes, tasks and communications.
5. Analysis of requirements and system designing.
6. Multiple use of model solutions.
   Case analysis: review of selected examples of modeling in UML. Selected applications.

EDUCATIONAL GOALS

Semester 1

1. Introduction to basic terms, models and methods of system analysis.
2. Teaching rules of modeling and analysis as well as evaluating information processes within a society (organization, institution).
3. Providing knowledge which will allow for an independent analysis of information systems and selection of effective techniques of system modeling and specific problems in evaluating information security in modern society.

Semester 2

1. Introduction to basic terms, models and methods of object oriented programming.
2. Providing knowledge in terms of creating rules and using object-oriented tools in designing information systems.
3. Providing knowledge which will allow for an independent analysis of information systems and applying means of object-oriented modeling (in particular UML).

SPECIFICATION OF LEARNING OUTCOMES

SPECIFICATION OF LEARNING OUTCOMES ON A SUBJECT LEVEL	**ASSESSMENT METHOD OF LEARNING OUTCOMES (FORM OF ASSESSMENT)**
Knowledge	
1. Student is able to demonstrate basic knowledge of computer systems analysis and engineering and rules of modeling.	Exam

2. Student is able to demonstrate basic knowledge of system analysis and object oriented modeling.	Exam
Skills	
1. Student is able to identify goals and functions, requirements and limitations in the process of system analysis for the needs of information systems modeling.	Exam Project task
2. Student is able to address issues relating to evaluation of system solutions, in particular using methods of structural and object-oriented modeling.	Exam Project task
3. Student is able to address issues related to information systems analysis and using object-oriented models in designing information systems (in particular UML).	Exam Project task
4. Student is able to identify positive and negative information related phenomenon in the process of information systems analysis and modeling for the needs of object oriented (structural) designing.	Exam Project task
Social competencies	
1. Student understands the role of selection and knowledge of analysis methods and information systems modeling in the process of designing and implementation specifically complex information systems.	Discussion Individual knowledge presented during laboratories
2. Student understands the need of continued self-education (especially analytical and project-related skills) as an IT specialist.	Discussion Individual knowledge presented during laboratories

2. DISTRIBUTED PROCESSING (5 ECTS)

LEARNING CONTENT
1. **INTRODUCTION TO THEORY OF CONCURRENT AND DISTRIBUTED PROCESSES. (**The architecture of a distributed process. Problems of critical section. Problems of communication and synchronization. Properties of distributed processes (property of fairness, property of liveness). Problems of reliability and testing of distributed processes. Problems of deadlock. Algorithm complexity in distributed processing. 2. **CLASSICAL ALGORITHMS AND ALGORITHMS OF DISTRIBUTED PROCESSING. (**Dining philosophers problem. Producers-

consumers problem. Readers-writers problem).

3. **COMMUNICATION AND DATA EXCHANGE IN DISTRIBUTED SYSTEMS. (**Standard EDI/EDIFACT. XML as a standard language for data exchange and communication. Synchronization of data exchange. XSD (XML Schema Definition) – definition of data exchange and communication protocol)
4. **TRANSACTIONS IN DISTRIBUTED SYSTEMS. (**Definition of transaction. Properties of transaction. The concept of isolation levels. Problem of blocking and efficiency. Distributed transactions. Mechanisms of managing and completing distributed transactions.
5. **EXAMPLES OF DISTRIBUTED SYSTEMS. (**Global distributed storage and data access systems (GOOGLE; FACEBOOK; YOUTUBE). Projects of global data processing (SETI&HOME; Einstein&Home; Platform BOINC; CLOUD COMPUTING).
6. **TECHNOLOGIES SUPPORTING THE CREATION OF DISTRIBUTED SYSTEMS.** (Semaphores, monitors, mutual exclusion, WebServices technology. Communications technology WCF. Technologies of asynchronous processing using queues. BROKER SERVICE. MSQ. IBM WebSphere).

EDUCATIONAL GOALS

1. Introducing the theory of distributed processing and parallel programming.
2. Teaching a selected data exchange standard to plan communication in distributed systems.
3. Providing knowledge of existing global systems of distributed processing.
4. Providing knowledge of technological solutions used in distributed systems.

SPECIFICATION OF LEARNING OUTCOMES

SPECIFICATION OF LEARNING OUTCOMES ON A SUBJECT LEVEL	**ASSESSMENT METHOD OF LEARNING OUTCOMES (FORM OF ASSESSMENT)**
Knowledge	
1. Student is able to demonstrate the knowledge of a distributed process and its properties.	Exam
2. Student is able to design the architecture of a distributed system and data exchange.	Exam
3. Student is able to demonstrate a systematized and theoretically grounded knowledge of methods, techniques and tools used in distributed systems.	Exam
Skills	
Cognitive skills	Laboratories

1. Student understands the concept of a distributed process and its properties.	
Cognitive skills 2. Student understands the concept of distributed transactions.	Laboratories
Cognitive skills 3. Student understands the principles of asynchronous processing in distributed systems.	Laboratories
Practical skills 4. Student is able to implement networked communication in a distributed environment.	Laboratories
Practical skills 5. Student is able to use XML and XSD to model data exchange and communication in a distributed environment.	Exam
Practical skills 6. Student is able to use queue technologies in distributed applications.	Discussion Individual knowledge presented during laboratories
7. Student is able to work independently as well as in a team. Student is able to estimate time needed to complete a given task;. He/she is able to manage a small team so as to accomplish a task within an appointed period of time.	Individual knowledge presented during laboratories Project completion
Social competencies	
1. Student understands the concept of a distributed system and is aware of problems that occur in a distributed environment.	Discussion Individual knowledge presented during laboratories
2. Student is aware of the need of continued self-education in order to maintain the potential to work within creating and using systems.	Discussion Individual knowledge presented during laboratories

3. ADVANCED SOFTWARE ENGINEERING (6 ECTS)

LEARNING CONTENT
1. ISO 9000 norm series (norms in the ISO 9000 series, quality management rules based on ISO 9001:2000, main requirements of the ISO 9001:2000 norm from quality management systems); Maturity Model CMMI (Capability Maturity Model Integration) – the concept of CMMI based on five levels of maturity, good practice concerning requirements management and planning a project. 2. Project management and methodology of PRINCE2® (introduction, structure of PRINCE2® model, basic processes in methodology of PRINCE2®). 3. Personal Software Process PSP (PSP methodology and is maturity levels, with special focus on the first two maturity levels – starting up process, planning, time and defects registers, problem of selecting measures for the code size, coding standard, form of self-improvement proposal, PROBE method used in PSP methodology to estimate size and effort , framework for a project.) 4. Factory methods: TSP (Team Software Process) and RUP (Rational Unified Process); methodology of TSP (Team Software Process) as a proposal to organize work for a team of programmers, who organize their own work on the basis of PSP (team organization TSP, TSP software development cycle), RUP (Rational Unified Process) methodology as one of the factory methods. 5. Acquiring and documenting requirements (standard IEEE 830, concerning requirements specification, good practice concerning the document that contains requirements); quality requirements and standard ISO 9126 (standard ISO/IEC 9126, including quality model and metrics). //2h 6. Project risk management (foundations of project risk management, risk management processes including: planning risk management, risk identification, performing qualitative risk analysis, performing quantitative risk analysis, risk response plan (risk transfer, avoiding risk, risk acceptance and risk mitigation) risk monitoring and risk control, risk structure model, possible risk responses). 7. Critical systems and HAZOP (the term of critical system, good practice of collecting and analyzing requirements for critical systems, HAZOP as a method used to analyze critical IT systems)//2h 8. Software sizing and software effort estimation (estimating the size of software and effort needed to build it – introduction, methods of software sizing and effort estimation including function point analysis, Wideband Delphi, COCOMO II, COCOMO II, Karner's method).
LEARNING GOALS
1. Introduction to models of improving software factory methods, methodologies of project management, standards of engineering requirements, approach to creating software for critical systems as well as

systematic approach to software sizing and effort estimation. 2. Acquiring the skill to apply the discussed standards, models, methodologies as well as methods and techniques in project management. 3. Pointing to students the possibilities of improving their qualifications and continued education with a focus on certification within the area of software engineering.

SPECIFICATION OF LEARNING OUTCOMES	
SPECIFICATION OF LEARNING OUTCOMES ON A SUBJECT LEVEL	**ASSESSMENT METHOD OF LEARNING OUTCOMES (FORM OF ASSESSMENT)**
Knowledge	
1. Knowledge of the norm series ISO9000 and maturity model CMMI.	Exam
2. Knowledge of methodologies of project management (PRINCE2®).	Exam
3. Knowledge of methodologies in building software (PSP, TSP, RUP).	Exam
4. Knowledge of rules of building software for critical systems.	Exam
5. Knowledge of methods and techniques of implementing projects.	Exam
Skills	
Cognitive skills 1. Knowledge of models of improving software development processes (ISO 9000, CMMI).	Laboratories
Cognitive skills 2. Knowledge of methodologies of project management (PRINCE2®, PSP, TSP, RUP).	Laboratories
Cognitive skills 3. Knowledge of norms concerning acquiring and documenting functional and quality requirements (standard IEEE 830, norm ISO 9126 and HAZOP method for critical systems).	Laboratories
Cognitive skills 4. Knowledge of process-oriented approach to project risk management.	Laboratories
Cognitive skills 5. Knowledge of methods and techniques of software sizing and effort estimation.	Laboratories

Cognitive skills 6. Skill to apply norms of the ISO9000 series to develop quality procedure and preparing quality policy for a typical company.	Laboratories
Cognitive skills 7. Skill to use CMMI model for evaluating the maturity level of a typical company.	Laboratories
Cognitive skills 8. Skill to use the methodology of PRINCE2® to manage an element of a given project.	Discussion Individual knowledge presented during laboratories
Cognitive skills 9. Skill to use techniques in PSP and TSP methodologies to improve one's own work or the work of subordinate team of programmers.	Discussion Individual knowledge presented during laboratories
Cognitive skills 10.Skill to use RUP methodology to manage an element of a given project.	Discussion Individual knowledge presented during laboratories
Cognitive skills 11.Skill to use standards for acquiring and documenting functional and quality requirements for a given project.	Discussion Individual knowledge presented during laboratories
Practical skills 12.Skill to manage risk in a given project.	Discussion Individual knowledge presented during laboratories
Practical skills 13.Skill to estimate the size of software and effort needed to build it (Wideband Delphi method, function point analysis, Karner's method, COCOMO II).	Discussion Individual knowledge presented during laboratories

Social competencies	
1. Skill to adjust the model of software development process to the characteristics of an implemented project and to be able to develop a project plan concerning software development process.	Discussion Individual knowledge presented during laboratories
2. Competencies needed to act as a team member and team project manager for software development project.	Discussion Individual knowledge presented during laboratories
3. Understanding the need to self-educate and improve one's own skills within the area of Project Management (participating in courses, using the knowledge and good practices available on thematic portals, self-education, e-learning).	Discussion Individual knowledge presented during laboratories

4. ADVANCED OBJECT-ORIENTED DESIGN (6 ECTS)

LEARNING CONTENT
1. Object oriented paradigm as mapping of terms of the conceptual level onto the level of code design on the specification level. The division of responsibilities between classes (class contracts). Examples. Mechanisms of the language supporting object-oriented paradigm: inheritance, access methods to data fields, polymorphism, reuse (types of parameters), abstraction and programming on an interface level (abstract classes). 2. Designing on a specification level (on interface or abstraction class level). Examples. Analysis of cases of inadequate division of problem into abstraction levels. Examples. Analysis of cases in which a class interface includes redundancy check. Negative influence of such situation on the code structure and the influence of the code on the abstraction level. Examples. 3. Design patterns as encapsulation methods of project variability. Simple examples. Creational patterns. Builder pattern and its application examples. 4. Selected creational patters: Abstract Factory, Factory Method. Application examples. Comparison of presented creational patterns and main idea of creational patterns. 5. Selected structural design patterns: Decorator, Facade, Composite, Bridge.

Bridge pattern as an idea of decoupling interface hierarchy from its implementation hierarchy – avoiding explosion of derived classes. Application examples.

6. Selected behavioral patterns: Iterator, Chain of responsibility, Mediator, Observer. Application examples.
7. Behavioral pattern State and its application in object oriented Project of opening and closing algorithm of TCP
8. Relations between classes (used in interface and used in implementation). Examples of designing with redundant relations between classes and undesired propagation of local changes onto the whole project. Project refactoring leading to a decrease in relations between classes; simple examples. Basic rules of project refactoring: collecting common properties in one base class, dividing classes into classes with important relations between methods; simple examples.

LEARNING GOALS

1. Mastering UML design notation of class diagrams and methodology of building object-oriented projects resistant to changes in requirements easily prototyped.

SPECIFICATION OF LEARNING OUTCOMES

SPECIFICATION OF ELARNING OUTOCMES ON A SUBJECT LEVEL	**ASSESSMENT METHOD OF LEARNING OUTCOMES (FORM OF ASSESSMENT)**
Knowledge	
Student is able to demonstrate knowledge of UML design notation of class diagrams and selected object-oriented design patterns.	Exam Completing end of semester project
Student is able to demonstrate basic knowledge of object-oriented programming.	Exam Completing end of semester project
Skills	
Cognitive skills 1. Student is aware of the importance of proper generalization of terms of model analysis in the process of object-oriented design.	Exam Completing end of semester project
Practical skills 2. Student is able to observe appropriate levels of abstraction in the conceptual model of the system and use it to properly encapsulate variation areas of the project.	Exam Completing end of semester project

Practical skills 3. Student is able to properly generalize terms that are the effects of the model analysis and apply these generalizations in an object-oriented design.	Exam Completing end of semester project
Practical skills 4. Student is able to document his/her own solutions to project tasks.	Discussion Completing end of semester project
Social competencies	
1. Student is aware of the importance of communication with specialists in the field of IT system design. Student is also aware that lack of such communication may inhibit proper generalization of terms of model analysis and hence prevent proper IT system design. Student is aware of the need of continued self-education and improving his/her communications skills and abilities to formulate problems in a precise manner.	Discussion Completing end of semester project

5. ADVANCED DATABASE SYSTEMS (6 ECTS)

LEARNING CONTENT
1. **Information systems (IS) and information technology systems (ITS).** Analysis of the term *system* , subsystem, environment, system management, input/ output information, feedback. Classification of systems. Definition of IS. Comparison of IS and ITS. IS classification. Criteria of IS classification. 2. **The concept of database and database management systems.** Conceptual database schema. Subject domain. Properties of subject domain. Data independence from user applications. Why is data independence needed? Integrated database. Advantages of integrated database. Attribute. The data set. File. Database management system components. Database subschema. Subschema definition language. Data manipulation language. Resident module. Types of DBMS. Three levels of database architecture. Conceptual data level. Physical data level. External data level. Data manipulation system. Database utility. Memory areas. 3. **Database system architecture.** Database users. Data definition language. Data manipulation language. Working memory. Data model. Data Submodel. Logical structure of database. Physical structure . User interface. Database management system. Database administrator functions. Database architecture software. 4. **Database properties.** Database integrity. Data security and protection. Data and applications independence. Supporting data relations. Multi-aspect access and data

sparing. Database performance. Transaction. Database reliability control. Transaction completeness control. The procedure for database restoration.

5. **Data models.**
   Data and information. Elementary data entity. Data interpretation. Visualization of terms. Data modeling. Classification of data models: models freely and precisely classifying. Data Model Schema, Entities, Types of Entities and Relationships. Data Model Components: Set of generating rules, Schema set, Set of operations. Data structure: Abstractions: generalization and aggregation operations. Types of data model: Sets, Set properties, Relations, Representations.
6. **Relational models of databases. Foundations of relational theory.**
   Definition of relational theory: Attribute, Domain, Relation, Degree of relation, Database, Tuple, Table, Relational model. Limitations to relational theory. Relational data model. Properties of relations. Normalization of relational data model. Levels of normalization. Normalized relation. Functional relation. Full functional relation. First normal form. Disadvantages of first normal form. Second normal form. Third normal form. Fourth normal form. Algorithm of leading data model to the fourth normal form.
7. **Data manipulation languages in relational data model.**
   Data language based on relational algebra. Basic operators in relational algebra. Data language based on relational calculus. Basic operators of relational calculus. Properties of language**s** of relational algebra and relational calculus: data independence, simplicity of formulating queries in languages of algebra and relational calculus, procedural character of the language of relational algebra and non-procedural character of the language of relational calculus, simplicity of database expanding. The language of algebra and relational calculus might form a base for creating languages. Queries in relational data model. Examples of realizing queries in the language of relational algebra.
8. **Query optimization.**
   Aims of query optimization. Optimization criteria. Architecture of the query evaluation environment. Optimization of queries through indexes. Index structure. Technique of index realization . Classification of indexes. Filtering indexes. Cost-based optimization of queries in relational databases. Rules of algebraic transformation in query optimization. Examples of algorithms for query optimization.
9. **Object-oriented databases.**
   General characteristics of object orientation in databases. Standards of object-oriented data model. Basic definitions in object-orientation. Object-relational databases. Object-oriented database management system. Object Query Language. Comparison of relational and object-oriented systems. Examples of object-oriented databases.
10. **Distributed databases.**

Properties of distributed systems of databases. Advantages and disadvantages of distributed systems. Popular distribution architectures. Classification of distributed databases. Communication in distributed databases. Transaction in distributed databases. Distribution rules. Replication. Ontology and meta data. Term *modeling*. Object-oriented distributed databases. Designing distributed databases. *Top-down* and *bottom-up* approaches. Horizontal and vertical fragmentation of relational databases. Architectures of distributed databases. Architecture client-server. Three-layer and multi-layer architecture. Application of different client-server architectures. Client-broker-server architecture. Standards in connecting distributed resources. Distributed transactions. Distributed transactions in JDBC.

11. **Data warehouses.**

Data warehouse and its place in data processing. Logical components of data warehouse. Physical structures of data warehouse. Central and federal data warehouse. Layer architecture of data warehouse. Metadata in data warehouse. Transactional system (OLTP) and analytical system (OLAP). Multidimensional analytical processing. Systems ROLAP, MOLAP and HOLAP. Choosing how to store data. Aims and stages of building data warehouse. Characteristics of the design stage. Examples of data warehouse designs.

LEARNING GOALS

1. Mastering adavanced techniques of managing the system of relational databases.
2. Learning the techniques of optimizing databases.
3. Mastering the rules of using non-relational types of data.
4. Mastering the rules of database migration between two systems of databases.
5. Mastering rules of creation and using object-oriented database.

SPECIFICATION OF LEARNING OUTCOMES

SPECIFICATION OF LEARNING OUTCOMES ON A SUBJECT LEVEL	ASSESSMENT METHOD OF LEARNING OUTCOMES (FORM OF ASSESSMENT)
Knowledge	
1. Student knows the rules of creating and documenting relational databases according to guidelines as well as the rules of formulating queries, making views, procedures and triggers.	Exam Completing end of semester project
2. Student knows the rules of creating distributed and object-oriented databases.	Exam Completing end of

	semester project
Skills	
Cognitive skills 1. Student understands the meaning of the proper structure, nomenclature used in relational database in the context of creating such database and in particular bigger databases.	Exam Completing end of semester project
Cognitive skills 2. Student understands the idea of a distributed database.	Exam Completing end of semester project
Cognitive skills 3. Student understands the idea of an object-oriented database.	Exam Completing end of semester project
Practical skills 4. Student is able to create a database according to guidelines, use non-relational types of data and make database migration	Exam Completing end of semester project
Practical skills 5. Student is able to create a distributed database and operate it.	Exam Completing end of semester project
Practical skills 6. Student is able to create an object-oriented database and operate it.	Discussion Completing end of semester project
Social competencies	
1. Student understands the role of precision in formulating problems. He/she is aware of the importance of the created context of database. He/she is also aware of the need to improve one's own skills in his/her career as an administrator or database programmer.	Discussion Completing end of semester project

6. DATA MINING (6 ECTS)

LEARNING CONTENT
1. The concept and importance of data mining (DM), the place of statistics in DM classification of DM methods, potential risks to data mining, the problem of distinguishing between correlation and causation, Anscombe's quartet.
2. Data types. Levels of measurement in the context of the term *relation*, nominal level, ordinal scale, interval and ratio scales. Data transformation, normalization and standardization.
3. Modeling functional relationships between data, linear regression. Nonlinear models. Examining quality of models.

4. Defining distance between datasets elements, the term *metric*. Classification methods, cluster analysis, k-nearest neighbors method. 5. The problem of dimension reduction, principal component method. 6. Text mining. Text representation, keyword frequency matrix. Cosine distance measure between texts. Latent semantic indexing. 7. WEB mining. PageRank algorithm. Website quality assessment (H&A) . 8. Association rules, association rules search algorithm. 9. Incomplete data mining.
LAERNING GOALS
1. The goal of learning is to provide knowledge of data mining and present basic methods and algorithms used in data mining.

DESCRIPTION OF LEARNING OUTCOMES	
DESCRIPTION OF LEARNING EFFECTS ON A SUBJECT LEVEL	**ASSESSMENT METHOD OF LEARNING OUTCOMES (ASSESSMENT FORM)**
Knowledge	
1. Student understands the consequences of using different data types. He/she knows methods and algorithms of effective solving problems within data mining field.	Exam
Skills	
Cognitive skills 1. He/she understands risks resulting from the criticism-free approach to data mining. He/she is able to counter such risks.	Exam
Practical skills 2. He/she is able to choose appropriate algorithms and methods for different data types. He/she is able to conduct adequate research and critically assess research results.	Exam
Social competencies	
1. He/she understands the meaning of data mining, but also understands risks resulting from incorrect data mining (category of responsibility)	Exam

7. MONOGRAPHIC SUBJECT I: APPLICATIONS OF INFORMATION TECHNOLOGY: SELECTED TOPICS IN INFORMATION AND COMMUNICATION TECHNOLOGIES (5 ECTS)

LEARNING CONTENT	
1. **Network structure and elements**. 2. **Preparation and delivering a presentation.** Report: structure and preparation method. 3. **Cable television**: The structure of cable television network. Subcarrier multiplexing – method of multiplying many different channels. Concentric cable or optical fibre. 4. **Mobile phone network**. The structure of mobile network. Mobile phone network of first generation. Mobile phone network of second generation. Mobile phone network of third generation. Mobile phone network of fourth generation. 5. **Satellite telecommunication.** Telecommunication satellites and their orbits**.** Transmission of television channels onto the Earth. Iridium System. Satellite telephony. 6. **Noise in telecommunication systems.** Thermal noise. Cosmic noise. Noise in semiconductor devices. Amplifier noise and amplifiers chain. Signal to noise ratio. 7. **GPS – Global Positioning System**. System design. The principle of operation. Galileo system.	
LEARNING GOALS	
1. Providing students with principles of operations, parameters, functionality of the most important information and technology communications in the modern world. At the same time students practise the skills to search for resources and publications, prepare and deliver presentation as well as independent work on technical report. Additional element of this subject is practising team work.	
DESCRIPTION OF LEARNING OUTCOMES	
DESCRIPTION OF LEARNING OUTCOMES ON THE SUBJECT LEVEL	**ASSESSMENT METHOD OF LEARNING OUTCOMES (ASSESSMENT FORM))**
Knowledge	
1. Student has a theoretical and detailed knowledge of the most important information and communications technologies in the modern world.	Presentation of selected topic Written report
2. Student has an up to date knowledge of developing	Presentation of

trends in computer science.	selected topic Written report
Skills	
1. Student knows how to acquire information from literature, data bases and other sources. He/she knows how to integrate acquired information, how to interpret and evaluate this information critically as well as how to draw conclusions and formulate and exhaustively justify opinions.	Presentation of selected topic Written report
2. Student is able to work independently as well as in a team. Student is able to evaluate time consumption of tasks. He or she is also able to manage a small team in a manner ensuring task completion before the deadlines.	Presentation of selected topic Written report
3. Student is able to formulate detailed documentation of results of the experiment execution, development task or research project. Student is able to develop a study describing results.	Presentation of selected topic Written report
4. Student is able to prepare and give a presentation on the subject of development task or research project execution as well as lead a discussion concerning the given presentation.	Presentation of selected topic Written report
Social competence	
1. Student understands the need of continued education and is able to inspire and organize the learning process for others.	Presentation of selected topic Written report

8. MONOGRAPHIC SUBJECT II: APPLICATIONS OF INFORMATION TECHNOLOGY:SELECTED TOPICS IN INFORMATION AND COMMUNICATION TECHNOLOGIES II (5 ECTS)

LEARNING CONTENT
1. **Transoceanic optic fibre cable**. Multi-mode and single-mode fiber optic cables. What is an optical transmitter built of? What kind of amplifiers are used? How does a regenerator work? 2. **Radar: the principle of operation and application.** General characteristics of a radar system. Distance measuring in an impulse radar. Speed measurement in a Doppler radar. What is Lidar? 3. **Modulation techniques.** Advantages and disadvantages of analogue modulation. Advantages and disadvantages of digital modulation. Digital modulation of laser optical power. Analogue modulation of laser optical

power.
4. **Digitization of analog signals**. ADC - Analog to Digital Converter – the principle of operation. DAC – Digital to Analog Converter – the principle of operation.
5. **Antenna**. Basic antenna parameters. Planar antennas. Satellite transmitters antennas. Mobile phone antennas.
6. **Systems WiMax, WiFi i Bluetooth**: the principles of operations and description of parameters.
7. **Telecommunication transmission cables**. structure and basic parameters. Cables of special application.
8. **Amateur radio.** Description of used equipment. Transmission techniques.
9. **Application of the effect of Doppler in modern telecommunication.**

LEARNING GOALS

1. Providing students with knowledge of principles of operation, parameters and functionality of the most important telecommunication systems in the modern world. At the same time students will practise the skill to search for sources and publications independently, prepare and deliver a presentation and individual work on technical report. An additional element of this subject is practising the skill to work as a team member.

DESCRIPTION OF LEARNING OUTCOMES

DESCRIPTION OF LEARNING OUTCOMES ON A SUBJECT LEVEL	ASSESSMENT METHOD OF LEARNING OUTCOMES (ASSESSMENT FORM))
Knowledge	
1. Student has a theoretical and detailed knowledge of the most important telecommunication systems in the modern world.	Presentation of selected topic Written report
2. Student has an up to date knowledge of developing trends in computer science.	Presentation of selected topic Written report
Skills	
1. Student knows how to acquire information from literature, databases and other sources. Student knows how to integrate acquired information, how to interpret and evaluate this information critically as well as how to draw conclusions and formulate and exhaustively justify opinions.	Presentation of selected topic Written report
2. Student is able to work independently as well as in a tea. Student is able to evaluate time consumption of tasks. Student is also able to manage a small team in a	Presentation of selected topic Written report

manner ensuring task completion before the deadlines.	
3. Student is able to formulate detailed documentation of results of the experiment execution, development task or research project; is able to develop a study describing results.	Presentation of selected topic Written report
4. Student is able to prepare and give a presentation on the subject of development task or research project execution as well as lead a discussion concerning the given presentation.	Presentation of selected topic Written report
Social Competence	
1. Student understands the need of continued education. He/she is able to inspire and organize the learning process for others.	Presentation of selected topic Written report

9. MONOGRAPHIC SUBJECT III: INTRODUCTION TO MACHINE LEARNING: ARTIFICIAL NEURAL NETWORKS AND GENETIC ALGORITHMS (5 ECTS)

LEARNING CONTENT
1. **Introduction to Machine Learning** 2. **Single-Layer Artificial Neural Networks** Biological motivation and history Perceptron and the perceptron learning rule Examples and limitations 3. **Multi-Layer Artificial Neural Networks** Transformation (activation) functions Vector and matrix notation Back-Propagation learning rule 4. **Genetic algorithms** Biological and social motivation Crossover, mutation and canonical algorithms. Applications 5. **Genetic Programming** Representation of programs Program generation Applications 6. **Examples and limitations** Applications of Artificial Neural Networks Advanced Artificial Neural Networks (optional)
LEARNING GOALS
1. Basic information about machine learning. 2. Knowledge of the structure and operation of artificial neural networks. 3. Basic knowledge of genetic algorithms and genetic programming.

DESCRIPTION OF LEARNING OUTCOMES	
DESCRIPTION OF LEARNING OUTCOMES ON A SUBJECT LEVEL	**ASSESSMENT METHOD OF LEARNING OUTCOMES (ASSESSMENT FORM)**
Knowledge	
1. Student has a sound knowledge of methodology, techniques and tools used in machine learning and in particular artificial neural networks and genetic algorithms.	Exam
Skills	
1. Student is able to construct Simple neural networks and apply them in machine learning.	Exam + Discussion
2. Student is able to construct and use genetic algorithms to solve specific problems.	Exam + Discussion
3. Student is able to apply genetic programming in automatic generation of computer programs.	Exam + Discussion
Social competencies	
1. Student is able to define his further education paths and self-education.	Discussion
2. Student is aware of the importance of his or her work as an engineer and understands other than technical aspects of his work such as such as environmental impact and responsibility for his or her decisions.	Discussion

10.MOBILE SYSTEMS (6 ECTS)

LEARNING CONTENT
1. **PROGRAMMING ENVIRONMENT J2ME. (**The characteristics of programming platform J2ME, Programming stack – Kernel-based Virtual Machine KVM, configurations, profile, Emulator description WTK (*Wireless ToolKit*), The specifics of creating software for mobile devices, creating mobile applications in MIDP profile – the so called MIDlets, Midlet lifecycle. 2. **INTRODUCTION TO THE SPECIFICATION OF MOBILE SYSTEMSS** (Definitions, basic functions, taxonomy of systems, types of connections and mobility. Technological evolution of mobile systems. Reasons for popularisation of mobile systems. Areas of research, development and industrial activity. Challenges of mobile systems. Network planning.

Multiple Access techniques: FDMA, TDAM, CDMA.

3. **MOBILE NETWORK DESIGN**. (Planning 2G mobile network coverage. 2G Mobile network dimensioning. Example of 2G mobile network design. Commentary to the principles of designing mobile network.
4. **EVOLUTION OF MOBILE NETWORK SYSTEMS.** Definition of *Roaming*. Classification of transfer procedures of the so called *Hand-over*. Stages of evolution in the architecture of mobile networks and its main factors. Architecture and principle of operating first generation mobile network (1G). Architecture and principle of operating second generation mobile network (2G). Technical parameters and physical channel realization.
5. **GSM SYSTEM. (**Architecture and principle of operation of mobile network systems of second generation (2G) – physical channel realization. Mechanism of advance transmission. Signal channel realization. Architecture of GSM Network: mobile station. Access network, skeleton network. Mobility management. Identifiers used in GSM Network. Functions of particular elements of architecture of: MS, BTS, BSC, MSC, GMSC, HLR, VLR, AuC. Mechanism of user authentication. Radio resources management and connection control management.)
6. **GSM AND GPRS SYSTEMS.** (Basic signal scenarios in GSM network: mobile station switching on and off, connection list, „hand-over" procedure, procedure of updating location. Roaming in GSM network, SMS service (*Short Message Service*), USSD service (*Unstructured Supplementary Service Data*). Data transmission in CSD mode and HS-CSD. Architecture and principle of operations of GPRS network, mobility management of GPRS network.)
7. **GPRS AND UMTS SYSTEMS (**Protocol of user interface and GPRS Network interface GPRS, physical and Signac channel realization. The term (*PDP Context*), signaling procedures: *GPRS Attach* and PDP *Context Activation*, EDGE (*Enhanced Data Rates for GSM Evolution*) System – changes as compared to GPRS system, UMTS system, the architecture of UMTS system. Functions and parameters of access network (UTRAN). Code Division Multiple Access (CDMA) – orthogonal codes. Protocols of user interface in UMTS Network. Organization of channels in UMTS network.)
8. **BLUETOOTH SYSTEM AND METHODS OF TERMINAL POSITIONING.** (General characteristics of Bluetooth technique. Organization of Bluetooth physical channel. Bluetooth protocol stack. Principles of access to medium using Bluetooth technique. Satellite positioning systems: history, the principle of operation, GPS system as an example of realization. Methods of positioning in mobile networks: Cell ID, RSS, TOA, TDOA, AOA.)

LEARNING GOALS

1. Obtaining knowledge of architecture and principles of operating mobile systems.

2. Obtaining practical skills in creating mobile phone applications using J2ME platform.	
DESCRIPTION OF LEARNING OUTCOMES	
DESCRIPTION OF LEARNING OUTCOMES ON A SUBJECT LEVEL	**ASSESSMENT METHOD OF LEARNING OUTCOMES (ASSESSMENT FORM)**
Knowledge	
1. Student has knowledge of network technologies,WPAN: Bluetooth.	Exam
2 . Student has a detailed knowledge of mobile systems and in particular architecture and principles of operations of network systems.	Exam
1. Student has a theoretical and detailed knowledge of software engineering within creating software on J2ME platform.	Laboratory Individual work on a task related to programming
Skills	
1. Student is able to create simple mobile phone applications using J2ME technology by a given deadline.	Laboratory Individual work on a task related to programming
2 . Student is able to use software Eclipse IDE and emulator WTK in order to create operating mobile phone application. .	Laboratory Individual work on a task related to programming
Social Competence	
1. Student understands the complexity of the architecture of mobile systems and the speed of change within this area.	Exam Discussion
2 . Student is aware of the role mobile systems (in particular mobile network systems) play in one’s life especially as a member of a society	Exam Discussion

11.FOUNDATIONS OF MANAGEMENT (5 ECTS)

LEARNING CONTENT
1. Global trends and possibilities and the need to use Internet and information technology in business activities. 2. Strategic meaning of information technologies at the macro and micro economic scale. 3. Business strategies based on IT applications. 4. The concept of virtual network organizations. 5. Virtual Network organizations – case analysis. 6. Theoretical foundations of assessment of organizational readiness of a company. 7. The meaning of organizational readiness in improving business results. 8. Organizational readiness scorecard and its application to assess the possibility of implementing IT solutions in a company. 9. IT and Internet solutions. 10. Internal and external business processes. 11. Company business situation analysis (Porter's five forces analysis, PEST, SWOT). 12. Formulating company e-vision. 13. Foundations of project management methodology. 14. Route map of IT projects. 15. Change management process. 16. The term and conditions for realization of business feasibility analysis. 17. Determining values of selected financial indicators and IT solutions. 18. IT career, factors in personal development.
LEARNING GOALS
1. Acquiring knowledge of basic issues in Internet applications and information technology in business activities. 2. Acquiring knowledge of assumptions and principles of economy. 3. Acquiring knowledge concerning assumptions and rules governing knowledge-based economy.

DESCRIPTTION OF LEARNING OUTCOMES	
DESCRIPTION OF LEARNING OUTCOMES ON A SUBJECT LEVEL	**ASSESSMENT METHOD OF LEARNING OUTCOMES (ASSESSMENT FORM)**
Knowledge	
1. Student has knowledge of global trends, possibilities	Discussion

and the need to use Internet and information technologies in business activities.	Research Team project Exam
2. Student has knowledge of Internet and information technologies as pro-developmental factors in businees and markets.	Discussion Research Team project Exam
3. Student has knowledge of business growth strategies and strategies of creating Virtual Network Organizations.	Discussion Research Team project Exam
4. Studenthas knowledge of concepts in management using information technologies.	Discussion Research Team project Exam
Skills	
1. Student is able to present Internet and information technologies as pro-developmental factors in business and markets. Student is able to describe strategies for growth in productivity, efficiency, innovation and profitability as well as strategies for creating Virtual Network Organizations.	Discussion Discussion
2. Student is able to explain the concept of managing using information technologies.	Discussion
3. Student is able to assess the degree of organization readiness of a company and explain the need to prepare an improvement plan.	Assessed work – research project
4. Student is able to describe application and meaning of Internet solutions to improve business processes.	Discussion Team project Exam
5. Student is able to make an analysis of an enterprise internal and external situation.	Discussion Team project Exam
6. Student is able to formulate an e-vision of achieving a success.	Discussion Team project Exam
7. Student is able to describe the meaning of change management in achieving a success through Internet and information technology projects.	Discussion Exam
8. Student is able to formulate goals in the form of research objectives.	Exam
9. Student is able to recognize when and how to prepare	Discussion

business feasibility analysis.	
Social competencies	
1. Student is able to use different sources to gain knowledge and prioritize their credibility and usefulness from the task's point of view.	Exam
2. Student is able to cooperate as a team member in order to achieve intended results.	Exam

12.ELECTIVE SUBJECT: DATABASES (Semester 1: 3 ECTS; Semester 2: 2 ECTS)

LEARNING CONTENT
Semester I 1. **Foundations of relational data model. (**Introduction to the subject. The history of database development. The features of relational database model. Operations on a relational model. The features of a relational diagram. Data normalization. Foundations of database design (ERD diagram). 2. **Database management systems** (The architecture of DBMS. The language of data. Data manipulation language. Data integrity. Methods and mechanisms ensuring data integrity. Referential integrity). 3. **SQL. (**Features and elements of SQL language. Data description language (commands CREATE, ALTER, DROP). Data manipulation language (commands INSERT, UPDATE, DELETE). Relational model basic operations; projection, selection and join. Query basics in SQL language). 4. **Queries in SQL.** (Exporting data from one table. Selection conditions. Organizing queries results. Joining tables. Aggregate functions. Grouping data. Filtering according to columns which result from aggregate functions. Types of table join. Inner join. Right and left join. Complex queries. Correlated queries. Non-correlated queries. 5. **T-SQL Language.** (Control structures. Conditional statement. Iterations. Statements WAITFOR PRINT and RAISEERROR. Exceptions handling. Views. Options used in defining views. Materialized views. Using views. Table functions.) 6. **Transactions and transactional mechanism. (**Definition and transaction features. Types of transactions. Transaction control in T-SQL. Optimistic and pessimistic concurrency models. Isolation levels. Clusters.). Semester II 1. **Advanced database query techniques**. (CTE expressions. Recursive queries using CTE expressions. Datasets transformation operations. Dynamic join CROSS APPLY. Transforming in window - operator OVER. Creating pivot table – join PIVOT. Positional filters – clause TOP and OFFSET … FETCH. Clause FOR XML – building query result as XML document. Query

optimization.).

2. **Non-relational types of data. (**Data type - XML. Methods of XML data type. Using XML methods In queries. Using expressions XPath and XQuery. Defining schemas XSD – XML SCHEMA COLLECTION. ID hierarchyid type . Methods of IT hierarchyid type. Using ID hierarchyid. Types of geometry and geography. Methods of spatial types. Using spatial data in queries. Non-relational types of data defined by user in CLR environment. Defining object-oriented types of data in CLR environment. Using CLR types to define tables.).
3. **Database programming.** (Stored procedure. Table-valued and scalar functions. Triggers. DML triggers. Inserted and deleted tables. EVENTDATA function. Asynchronous processing - SERVICE BROKER. Defining elements of the architecture of SERVICE BROKER. Static and dynamic queues.).
4. **Database security**. (Database security rules. User rights, server roles and database roles. User rights management. Using elements of cryptography. Creating backup servers. Mechanism LOG SHIPPING. Mechanism of replication. MIRRORING.)
5. **Elements of database administration.** (Backup copies. Database restore models (model SIMPLE, FULL and BULK LOGGED). Strategies for creating backup copies. BACKUP DEVICE. Security rules management - POLICY MANAGEMENT mechanism. Dynamic allocating of resources – RESOURCE GOVERNOR. Capturing data changes – DATA COLLECTION. Strategy AlwaysON. Automating administrative tasks - MAINTENANCE PLANS.

LEARNING GOALS

1. Teaching using SQL language to define the scheme of database.
2. Teaching the rules and techniques used in query realization in SQL language.
3. Teaching stored procedure programming and triggers.
4. Providing foundations of transactional transformation.
5. Presenting mechanisms of database systems security.
6. Presenting database administration.

DESCRIPTION OF LEARNING OUTCOMES

DESCRIPTION OF LEARNING OUTCOMES ON A SUBJECT LEVEL	**ASSESSMENT METHOD OF LEARNING OUTCOMES (ASSESSMENT FORM)**
Knowledge	
1. Student has a extended theoretical knowledge of basic methods, techniques and tools used to solve IT tasks based on databases.	Exam Tasks done during laboratories Discussion (lab.)

Skills	
Practical skills 1. Student is able to implement databases in the environment of the selected database management system on the base of designed scheme.	Individual knowledge presented during laboratories Discussion
Practical skills 2. Student is able to use SQL language to complete tasks in a relational database environment.	Exam
Social Competence	
1. Student understands and appreciates rules of using relational databases to support business processes.	Individual knowledge presented during laboratories Discussion
2. Student is aware of the need of continued education and continuous improvement of his/her own skills in order to retain the potential of possibilities in database environment.	Individual knowledge presented during laboratories Discussion

13.ELECTIVE SUBJECT II: NETWORK TECHNOLOGIES (Semester 1: 3 ECTS; Semester 2: 2 ECTS)

LEARNING CONTENT
Semester 1 1. **Designing LAN network.** Hierarchical model of LAN network. Functions of switches in LAN network.. Addressing in IP network. Addressing in subnets, rules of determining group address. 2. **LAN switching.** Switching in layers 2 and 3. Symmetric and asymmetric switching. Methods of switching store-and-forward, cut-through. Characteristics of selected switching devices of access layer, distribution layer and core layer. 3. **Configuration and management of switches.** Managing MAC address table. Securing switch and ports against illegal access. Passwords recovery procedures and managing configuration files. Protection against typical layer 2 attacks. 4. **Virtual LAN networks.** Static and dynamic VLAN configuration rules. Broadcast domains and VLAN networks. Routing between VLAN networks. VTP protocol.

5. **Spanning tree protocol.** Characteristics of broadcast storm and MAC address table instability. Discussion of spinning tree algorithm.
6. **Protocols of dynamic routing for LAN.** Technique VLSM. Route aggregation using VLSM. Default router – broadcasting. Problems of classless routing.
7. **NAT protocol**. Design features of NAT protocol. NAT protocol configuration. Diagnosing and solving problems of wrong protocol configuration.

Semester 2

1. **Filtering network traffic using access control lists (ACL).** Standard access control lists. Extended access control lists. Analysis of use cases and rules of application.
2. **Dynamic access control lists.** Dynamic access lists of lock-and-key type. Reflexive access lists. CBAC lists. Analysis of use cases and rules of applying dynamic access control lists.
3. **Highly efficient protocols for dynamic routing based on EIGRP example.** Characteristics of EIGRP protocol. Design features of EIGRP protocol. Configuration and solving problems with protocol.
4. **OSPF protocol.** Design features of OSPF protocols. Using OSPF protocol within a single area. Configuration of multi-area OSPF.
5. **FrameRelay protocol.** Virtual circuit. Configuration of FrameRelay switch and PVC circuits. Configuration and connecting DTE devices to FrameRelay network.
6. **Introduction to network administration.** Characteristics of SNMP protocol. Architecture of network management system based on SNMP protocol. Monitoring the status of network devices using SNMP agents.
7. **Flow and congestion control in TCP protocol.** Flow control using a sliding window. Avoiding congestion using RED gateway. Flow control and reaction to congestion in TCP protocol.

LEARNING GOALS

1. Learning foundations of designing and implementation of local area networks.
2. Understanding rules of switching packets through layer 2 and 3 network devices used in LAN and WAN networks.
3. Comfortable use of configuration interface of network devices and learning rules of configuration of devices used to work in IP network.

DESCRIPTION OF LEARNING OUTCOMES

DESCRIPTION OF LEARNING OUTCOMES ON A SUBJECT LEVEL	ASSESSMENT METHOD OF LEARNING OUTCOMES (ASSESSMENT FORM)

Knowledge	
1. Student has an extended knowledge of methodology, techniques and tools used in designing and implementing ICT networks.	Exam
Skills	
1. Student knows how to configure network devices to work in network using IPv4 protocol. Student is able to search for information from literature, databases and other sources and is also able to integrate information, interpret and assess critically as well as draw conclusions and formulate and justify opinions.	Tasks completed during laboratories Discussion (lab.)
2. Student is able to create and use technical documentation.	Tasks completed during laboratories Discussion (lab.)
3. Student is able to design, configure and manage LAN networks on a beginner's level.	Tasks completed during laboratories Discussion (lab.)
Social competence	
1. Student is able to define one's own further education paths and be able to self-educate. .	Discussion (lab.)
2. Student is aware of the importance of his or her work as an engineer and understands other than technical aspects of his work such as environmental impact and responsibility for his or her decisions.	Discussion (lab.)

14.ELECTIVE SUBJECT III: DIGITAL TECHNOLOGY (5 ECTS)

LEARNING CONTENT
1. **Relations and software – equipment, relations between logic and digital technology.** .
2. **Theoretical foundations of logic: Boolean algebra and its values and laws, duality, logic gates, canonical form of the sum of products and product of sums. Minimization of logic functions using the Karnaugh map.**
3. **Synthesis of combinational logic:** Examples of selected uses of combinational logic: binary addition (1-bit adder, half adder, parallel adder).
4. **Demultiplexer, multiplexer**, realization of combinational functions using demultiplexer and multiplexer.
5. **Synchronous sequential logic:** D flip-flop – truth table. Examples of using flip-flop to implement synchronous sequential logic.

6. **Trends and limitations to the development of microprocessor technology.** Moore's law.	
LEARNING GOALS	
1. Providing knowledge of design methods and analysis of efficiency and complexity of algorithms.	
DESCRIPTION OF LEARNING OUTCOMES	
DESCRIPTION OF LEARNING OUTCOMES ON A SUBJECT LEVEL	**ASSESSMENT METHOD OF LEARNING OUTCOMES (ASSESSMENT FORM))**
Knowledge	
1. Students understand the relation between logic, Boolean algebra and Digital technology. Students know about logic gates and basic functional blocks of higher level. Students know ways of implementing logic functions. They also know the difference between combinational and sequential logic. Students know the trends in the development of microprocessor technology.	Exam tasks completed individually Discussion
Skills	
Cognitive skills 1. Students are able to design simple combinational blocks and simplest synchronous sequential blocks. Students are able to make a synthesis of basic digital systems on the level of functional blocks.	Exam
Practical skills 2. Students are able to find the canonical form of the sum of products. Students are able to minimize logic functions. Students are able to realize combinational functions from logic gates or from blocks such as multiplexer and demultiplexer.	Exam
Social competencies	
1. Students are aware of the developmental trends in microprocessor technology and hence are able to participate in taking responsibility for making investment-related decisions in companies and when working for an individual client.	Exam
2.	

15.SPECIALIZED INTERNSHIP (5 ECTS)

LEARNING CONTENT
1. Introduction to the subject/rules of working discipline, internal regulations, health and safety at work. Internship Schedule – establishing the scope of duties. Information about a company or an institution. The history and current activities. Organizational structure and ongoing tasks. 2. Presentation of IT systems and software used in the organization. 3. Completing tasks within current maintenance services. -help in solving users' problems, - installation of new computers and peripheral devices, - determining the technical state of equipment in use, - identifying and analysis of damages, - repairing damaged equipment, - cooperation with servicing team. 4. Realization of an assigned practical task connected with his/her educational specialization and one that serves the aims of the organization. 5.Participation in tasks and activities of the organization with information technology field. 6. Internship summary and presentation of results.
LEARNING GOALS
1. Acquiring specialized practical knowledge within at least one of the IT applications used by the organization. Acquiring team work skills and developing autonomy, responsibility and independence.

DESCRIPTION OF LEARNING OUTCOMES	
DESCRIPTION OF LEARNING OUTCOMES ON A SUBJECT LEVEL	**ASSESSMENT METHOD OF LEARNING OUTCOMES (ASSESSMENT FORM)***
Knowledge	
1. Student has an extended practical knowledge of at least one of the following computer science issues: − advanced algorithms and programming methods, − operations systems, − network technologies, − graphics and multimedia foundations, − databases,	

– embedded systems, – foundations of digital security, – elements of IT and ICT systems administration and management, – IT systems modeling, – ICT foundations, – data processing and data analysis, – selected computer science applications	
Skills	
1. Student is able to solve complex IT problems through obtaining information independently. Student is able to interpret and integrate obtained information as well as formulate and justify his/her opinions.	
2. Student is able to work individually and as a team member and is able to assess the time needed to complete a given task.	
3. Student is prepared to work for a company or an institution holding a position connected with at least one of the computer science field.	
Social Competencies	
1. Student is able to cooperate as a team member.	
2. Student understands the need to share knowledge of one of the computer science fields within the organization and is able to convey it in a way that is universally comprehensible.	

*ASSESSMENT METHOD OF LEARNING OUTCOMES (ASSESSMENT FORM)

Assessment method of learning outcomes is performed on the basis of the opinion issued by the internship supervisor who confirms whether the student acquired the competencies stated in the subject syllabus.
In case students gain credit for the internship by means of professional work (employment contracts, civil agreements) the assessment method is performed on the basis of an employer certificate confirming whether the student acquired learning goals defined in the subject syllabus.
In case students gain credit for internship by means of their own self-employment within the IT sector the assessment is performer by the Rector's representative responsible for students' internships after an analysis of student's declaration on his/her achievements within their self-employment that can be recognized as learning outcomes defined in the subject syllabus.

Specialized learning content

Specialization: PROJECT MANAGEMENT

1. PROJECT EVALUATION AND VALIDATION (7 ECTS)

LEARNING CONTENT
Semester 1: 1. **PROJECT IDENTIFICATION** (Concept, place and role of project in management. Definitions and classes of project. Concept of design. Basic functions and project management cycle. Basic design cycle. Identification of project needs. Areas of project management. Formal structures of project. Complexity, cost and value of projects). 2. **CLASSIFICATION AND PROJECT LIFE CYCLE (**Types of projects. Product life cycle and project life cycle. Analysis of needs and defining requirements. Analysis of project assumptions and limitations. Developing the concept of solutions. Developing logic and functional models. Design and verification. Documentation and closing project. Implementation and execution. Improving. Cancelling a project. Project systems and strategies. 3. **PROJECT VALUATION-** Part-I (design cost, effects and value of project, economic indicators of project value, break-even point in designing, safety margins in a project, project budget). 4. **PROJECT VALUATION-** Part-II (Project evaluation and control criteria. Analysis of project value. Single-indicator methods. Multi-indicator methods. Project and project needs prioritization.). 5. **SYSTEM CRITERIA FOR PROJECT VALUE** (Structure and scope of system criteria. Project usability and functionality. Managing project effectiveness and functionality. Effects and effectiveness indicators. Effectiveness of project activities. Profitability. External effectiveness. Estimation and project feasibility study). 6. **RISK MANAGEMENT** (Project defects and mistakes during execution. Defining and classification of threats. Sources of risk in designing. Planning project risk. Planning control and results verification. Evaluation criteria and criteria for project control. Risk management methods). **Semester 2:** 7. **PROJECT QUALITY** (Product, process and project quality. Quality measurement and criteria. Quality management. Quality management methods. Standards and procedures of quality assessment).

8. **TIME AND COST OPTIMIZATION OF PROJECT** (Methods and techniques of time estimation. Critical path method. Methods of assessing time consumption of project. Time and cost optimization methods. Development of time and cost methods).
9. **ORGANIZATION AND VALUATION OF DESIGN AUTHORITY** (Place of the design authority in the structural organization of an enterprise. Organizing and planning the structure of project teams. Linear and functional models. Matrices models. Network and virtual models. Hybrid models. Tasks and division of project teams. Institutional forms of project management. Control and assessment of project teams.
10. **EFFECTIVENESS AND ERGONOMICS OF ENTERPRISE** (Financial expenditure. Project logistics. Project infrastructure. Organizational design models. Effectiveness of activities. Project communications management).
11. **TECHNIQUES AND TOOLS FOR SUPPORTING DESIGN AND PROJECT MANAGEMENT.** (Structural methods and object-oriented methods. System analysis. System engineering. Heurisitc methods. Methods of utility and design patterns. MS PROJECT packet functionality. Systems of computer aided design CAD/CAISE. Group work and project management through project repository. Time, cost and spatial aspects).
12. **CRITERIA FOR ASSESSMENT AND PROJECT ACCEPTANCE** (Areas and scope of assessment. Developmental trends in project management. Rhomboidal method in project management. Strategic scorecard. Strategic concepts of project management).

LEARNING GOALS

1. Teaching methods and techniques of project decomposition and assessing their complexity.
2. Teaching rules of identifying system features and design processes.
3. Teaching methods and techniques for time and cost project valuation.
4. Teaching criteria for assessment and project acceptance.
5. Teaching systems of computer aided design and project management in the context of project investment.

DESCRIPTION OF LEARNING OUTCOMES

DESCRIPTION OF LEARNING OUTCOMES ON A SUBJECT LEVEL	**ASSESSMENT METHOD OF LEARNING OUTCOMES (ASSESSMENT FORM)**
Knowledge	
1. Student knows methods and techniques of identification, decomposition and multi-aspect	Exam

valuation of projects.	
2. Student knows methods and techniques of valuation analysis in designing.	Exam
Skills	
Cognitive skills 1. Student understands the need to measure a project and assess its complexity as well recognize system criteria.	Analysis and project laboratory classes
Cognitive skills 2. Students understands cost and time relations in designing.	Analysis and project laboratory classes
Cognitive skills 3. Student recognizes quality features of project and the key role of risk in designing.	Individual work and presentation
Practical skills 4. Student is able to define the tree of the project and assess its complexity. Student is able to value a project and use the idea of value analysis as well as interpret its results in designing.	Exam Discussion Tests Individual knowledge presented during laboratories
Cognitive skills 5. Student is able to apply selected time and cost optimization methods and estimate the level of certainty of executing a project.	Exam Discussion Tests Individual knowledge presented during laboratories
Practical skills 6. Student is able to interpret quality in terms of ex-post and ex-ante and is able to make a system assessment of design results as well as indicate criteria for their acceptance.	Exam Discussion Tests Individual knowledge presented during laboratories
Social competencies	
1. Student recognizes the role of system aspect in perceiving designing and relations of project complexity with expenditure and design effects. Student perceives designing and structure of IT systems as a complex object of designing which itself is a significant investment and innovation In the life of an organization. Student acknowledges precision in formulating project problems as a basis of	Discussion Tests Individual knowledge presented during laboratories

rationalization and deliberate consumption of resources in each activity.	
2. Student is aware of the need to constantly improve his/her skills of building, maintaining, estimation and valuation of IT systems.	Discussion Tests Individual knowledge presented during laboratories

2. MODELS AND SYSTEM DESIGN (4 ECTS)

LEARNING CONTENT
1. Models of planning and organization of design projects. Design subject, process and object. Basic structures and organizational models of teams. Organizational structure of a Project. Project planning. 2. IT system as a design subject. Project and system complexity. Organizational and functional structure of an IT system. IT system engineering (logic, functional and physical models). Subject structure of an IT system. Layer model of an IT system. ICT system. 3. Design process of an IT system, stages and models of software architecture. System analysis in identifying limitations and IT system models variants. Organizational models of IT system design (waterfall model, V-model, iterative model, …). Main stages and characteristics of implementation phase of a project. Pre-implementation analysis. Selection of an IT solution and contracting. System implementation. 4. Requirements analysis and system modeling. Structural modeling. Object-oriented modeling. Modeling with the use of design and user patterns. 5. IT system design. Criteria for proper definition of an IT system project. Structural design, object-oriented design. Design with the use of project and user patterns. 6. Implementation, testing, maintenance and development of an IT system. Stages of implementation and testing phases. Software coding and testing methods. Issues and stages of IT system maintenance phase. 7. Computer aided software engineering (CASE). Functional quality of CASE tools (norm ISO/IEC 25010). Functionality of UPPER-CASE and selected realizations. Functionality of LOWER-CASE and selected realizations. Functionality of I-CASE and selected realizations. Functionality of C-CASE and selected realizations. Characteristics and features tools used to assess artifacts created during design. Structural and object environment of CASE. Tools for modeling in UML. Tools used to manage configuration in version

control systems (e.g. Subversion SVN). Reverse engineering tools. Refactoring tools. Characteristics of CAD systems functionality. 8. Computer Aided Systems of IT Project Management. Features of CASIPM. Functionality of selected CASIPM. Project repository and IT Project management. 9. Seminary preparation and presenting a paper.
LEARNING GOALS
1. Acquiring knowledge of models and methods of IT system design. 2. Acquiring knowledge of computer aided software engineering (CASE).

DESCRIPTION OF LEARNING OUTCOMES	
DESCRIPTION OF LEARNING OUTCOMES ON A SUBJECT LEVEL	**ASSESSMENT METHOD OF LEARNING OUTCOMES (ASSESSMENT FORM)**
Knowledge	
1. Student knows foundations of modeling, rules of structural and object oriented IT system modeling	Exam
2. Student knows organizational structures of project, stages and models of IT system design, rules of structural and object oriented IT system design.	Exam
3. Student knows functions of computer aided software engineering (CASE) and computer aided systems of IT project management.	Test Gaining credit for a model and completing a semester project
Skills	
Cognitive skills 1. Student understands the difference in structural and object oriented methods of IT system modeling.	Exam
Cognitive skills 2. Student understands the difference in models of IT system design. Student knows advantages and disadvantages of models of IT system design.	Exam
Cognitive skills 3. Student understands the benefits resulting from applying computer aided software engineering (CASE).	Test Gaining credit for a model and completing a semester project
Practical skills 4. Student is able to identify the most important elements	Test Gaining credit for a

and limitations of an IT project within project criteria.	model and completing a semester project
Practical skills 5. Student is able to select proper tools for modeling in structural and object oriented methods of modeling.	Laboratory classes
Social competencies	
1. Student values the role of precision in IT system modeling.	Discussion Test Individual knowledge presented during laboratories
2. Student is aware of the importance of proper project management, in particular the aspects of assumed time, cost, quality and scope of the project.	Discussion Test Individual knowledge presented during laboratories
3. Student is aware of his/her place in a project team according to the accepted organization model.	Discussion Test Individual knowledge presented during laboratories

3. PROJECT MANAGEMENT METHODOLOGIES (10 ECTS)

LEARNING CONTENT
1. Basic terms in Project Management (Project, program, Project port folio, Project management, program management, Project port folio management; the role of project manager, project life cycle and product life cycle; Project and operations activity; Project stakeholders; influence of organizational structure on Project management; standards (methodologies) of Project Management (the term *methodology*, division of Project Management methodologies, basic methodologies – standards of Project Management based on examples); methods of selecting projects for implementation. 2. Methodology PMI® (Project Management Institute) – part 1, model of project life cycle in PMI® methodology (groups of processes of Project Management, areas of knowledge of project management, mapping groups of processes onto areas of knowledge 3. Methodology PMI® (Project Management Institute) – part 2, selected good

practices and techniques used in PMI® methodology in each of the areas of knowledge of Project Management based on examples (integration management, scope management, time management, cost management, quality management, human resources management, communication management, risk management, orders and contracts management).
4. Methodology PRINCE2® - part 1, model of Project life cycle in PRINCE2® methodology (rules, themes, processes, project environment).
5. Methodology PRINCE2® - part 2, selected good practices and techniques used in PRINCE2® methodology and distinguishing features of PRINCE2® among other Project Management methodologies (Quality Review technique and Product Based Planning technique
6. Methodology APM® (Agile Project Management), Project life cycle in APM® methodology, selected good practices and techniques used in APM® methodology.
7. Methodology RUP® (RationalUnifiedProcess), Project life cycle in RUP® methodology, selected good practices and techniques used in RUP® methodology.
8. Methodology SCRUM, Project life cycle in SCRUM methodology, selected good practices and techniques used in SCRUM methodology.
9. Other selected standards (methodologies) of Project Management (methodologies SixSigma, MSF – Microsoft Solution Framework, LPM - Lean Project Management, SixSigma+LPM, PCM – Project Cycle Management); Project Management Standards (methodologies) development.
10. Summary. Preparation to the exam covering this lecture.

LEARNING GOALS

1. Providing Students with a basic knowledge of Project Management resulting in the knowledge of Project Management problems and IT Project Management.
2. Presenting Students basic standards of project management (PMI®, PRINCE2®, APM®, RUP, SCRUM, MSF, SixSigma, LPM, PCM) which might occur when working for IT companies and public and local administration units.
3. Practical presentation of selected good practices and techniques necessary to initiate, plan, implement, monitor, control and close a project in each of the discussed standards.
4. Indicating possibilities of improving qualifications and continued education and certification within the area of Project Management.

DESCRIPTION OF LEARNING OUTCOMES

DESCRIPTION OF LEARNING OUTCOMES ON A SUBJECT LEVEL	ASSESSMENT METHOD OF LEARNING OUTCOMES

	(ASSESSMENT FORM)
Knowledge	
1. Knowledge of basic terms connected with Prject Management (understanding the specific vocabulary connected with Project Management).	Exam
2. Knowledge of models of Basic methodologies (standards) of Project Management (PMI®, PRINCE2®, APM®, RUP, SCRUM, MSF, SixSigma, LPM, PCM) which might occur on student's professional work in IT companies and public and local administration units. .	Exam
3. Practical knowledge of good practices and techniques necessary to initiate, plan, implement, monitor, control and close a project in each of the discussed standards.	Test Gaining credit for a model and completing a semester project
4. Knowledge allowing to define one's own professional career path within the area of Project Management. .	Test Gaining credit for a model and completing a semester project
Skills	
Cognitive skills 1. Basic knowledge and understanding of terms and concpets of Project Management. .	Exam
Cognitive skills 2. Basic knowledge of selected methods and techniques as good practices used in discussed methodologies of Project Management.	Exam
Cognitive skills 3. Knowledge of common and distinguishing elements of discussed standards (Project Management methodologies).	Test Gaining credit for a model and completing a semester project
Practical skills 4. Ability to use and understand the vocabulary connected with Project Management. .	Test Gaining credit for a model and completing a semester project

Practical skills 5. Ability to apply selected techniques to choose a project for implementation.	Test Gaining credit for a model and completing a semester project
Practical skills 6. Ability to select a proper methodology according to a given project.	Laboratory classes
Practical skills 7 . Ability to use selected good practices in discussed standards of Project Management. .	Laboratory classes
Practical skills 8. Ability to apply selected techniques to initiate, plan, implement, monitor, control and close a project in each of the discussed standard (methodologies) of Project Management.	Laboratory classes
Social Competencies	
1. Competencies required to perform the role of a project team member.	Discussion Test Individual knowledge presented during laboratories
2. Understanding the need to constantly improve one's level of knowledge and skills within the area of project management (participating in courses, workshops, using the knowledge and good practices available on thematic portals, self-education, e-learning).	Discussion Test Individual knowledge presented during laboratories

4. SIMULATION AND EXPERT SYSTEMS IN DESIGN (9 ECTS)

LEARNING CONTENT
1. **INTRODUCTION TO SIMULATION MODELING. (**Mathematical modeling in economy and management; Dynamic systems; Types of formal models; Etymology of simulation; Historic and philosophical sources of simulation. Examples of models and simulation research. 2. **METHODOLOGICAL ISSUES IN SIMULATION MODELING. (**Definitions, modeling structures; Stages of building simulation models; Verification and validation of simulation models, Simulation experiment;

Inference from simulation research results.)

3. **METHODS AND TECHNIQUES OF SIMULATION MODELING. (**Continuous simulation (J.W. Forrester's method), discrete simulation (methods of planning events, review and selection of activities, interaction of processes) and hybrid simulation; Simulation games; Integration of simulation and artificial intelligence; Web, distributed and agent simulation).
4. **APPLICATION OF SIMULATION RESEARCH IN DESIGN AND MANAGEMENT** (Examples of simulation Project; problems of conveying simulation results; Documenting simulation projects and standardization. Professionalism and ethics in simulation).
5. **PREPARING SEMINAR AND PRESENTING A PAPER according to GROUP TASKS**
6. **KNOWLEDGE ENGINEERING – METHODS OF KNOWLEDGE REPRESENTATION (**Basic terms of intelligence and artificial intelligence; classical methods of knowledge representation based on using logic (conventional logic: propositional calculus, predicate calculus, resolution method), non-conventional logic (fuzzy logic, many-valued logic), Methods using statements, methods using rule-based systems (knowledge vectors); Methods using semantic networks. Methods based on phrases. Methods using calculus models.
7. **EXPERT SYSTEMS** (Expert Systems idea. Functional structure and architecture of ES. Acquiring knowledge in ES. Stages in building ES. Rule-based representation of knowledge. Rule-based reasoning.
8. **SELECTED TECHNOLOGIES OF BUILDING EXPERT SYSTEMS. (**Technological environments of ES. Selected examples of ES. Presentation of the packet of artificial intelligence Sphinx (including PC Shell). ES Assessment.
9. **APPLICATION OF EXPERT SYSTEMS IN DESIGN AND MANAGEMENT. (**Examples of expert projects. Problems of using expert systems in IT system engineering.)

LEARNING GOALS

1. Providing basic information about simulation as a research method and analysis of complex dynamic systems.

2. Introducing students to possibilities of languages and tool systems of modeling and computer simulation.

3. Preparing students to use simulation models and work with simulogs.

DESCRIPTION OF LEARNING OUTCOMES ON A SUBJECT LEVEL	**ASSESSMENT METHOD OF LEARNING OUTCOMES (ASSESSMENT FORM)**

Knowledge	
1. Student has basic information about simulation as a research method and analysis of complex dynamic systems.	Exam
2. Student knows basic classes of simulation models and possibilities of languages and tool systems of modeling and computer simulation.	Exam
3. Student understands the idea of artificial intelligence and knowledge-based systems (including expert systems); student knows the areas of application of expert systems and other tools of artificial intelligence.	Test Course credit for a model and semester project
4. Student is able to analyze and assess possibilities (advantages, disadvantages, benefits and risks) of applying expert systems and other tools of artificial intelligence in system engineering.	Test Course credit for a model and semester project
Skills	
Cognitive skills 1. Student understands the idea of continuous and discrete simulation as a scientific method of research in complex systems.	Exam
Cognitive skills 2. Student understands the idea and modern approaches in developing knowledge-based systems (including expert systems)	Exam
Practical skills 3. Student is able to build simple models based on discrete simulation using spreadsheet, *Arena* system and GPSS language.	Test Course credit for a model and semester project
4. Student is able to determine his/her own further education paths.	Course credit for a model and semester project
Practical skills 5. Student is able to classify and discuss the areas of application of expert systems and other tools of artificial intelligence in system engineering.	Test Course credit for a model and semester project
Practical skills 6. Student is able to analyze and assess possibilities (advantages, disadvantages, benefits and risks) of applying expert systems and other tools of artificial intelligence in system engineering.	Laboratories
7. Student is able to determine his/her own further education paths.	Discussion Tests Individual

	knowledge presented during laboratories
Social competences	
1. Student values the role of simulation systems and expert systems using selected commercial standards. Student understands the need for such systems in system engineering and supporting decision making process.	Discussion Tests Individual knowledge presented during laboratories
2. Student is aware of the need of continuous improving his/her skills in order to integrate different solutions in the context of discussed environments, tools and programming languages.	Discussion Tests Individual knowledge presented during laboratories

5. DIPLOMA SEMINAR (5 ECTS)

LEARNING CONTENT
Semester 3 Three hour sessions are allocated to each of the seminar. Examples of seminar topics: 1. Discussion of issues connected with the process of writing a dissertation. 2. Selected topics in distributed and parallel processing. 3. Selected topics in the architecture and operations of supercomputers and computer clusters. 4. Selected propositions of future computers. 5. Selected topics in information exchange security in ICT networks. 6. The architecture, operation and application of IDS and IPS systems. 7. IT system design with design and system patterns. 8. Reference model in information system used to acquire knowledge. 9. Selected aspects of human resources management in an IT Project. 10. Technical and functional structures of modern information systems. **Semester 4** Seminar classes are based around MSc candidates' activeness and aim at gradual and effective process of writing a Master dissertation within the area assigned by the name of the seminar group. Master's dissertation should include a creative element and bring certain new values or generalizations into the design and implementation practices. – Identification of the topic, – The plan of seminars and forms of crediting the seminar,

- The plan of documenting and realization of the dissertation,
- Technique and organization of work on dissertation,
- The field of the problem of the dissertation,
- Information and information technology systems models,
- Stages and phases of modeling process,
- The structure and contents of Master's dissertation,
- Main components of the dissertation,
- Selection and justification of the dissertation topic,
- Functional decomposition of the dissertation subject,
- Formulating the aim of the dissertation,
- Formulating research problems,
- Formulating working hypothesis,
- Defining the scope of solutions,
- Research methods and tools,
- Literature

Each seminar class (with the exception of the first and last seminar) will consist of two main parts:

1. report part – concerns candidates' reports on the progress of the dissertation and results of work assigned to candidates during previous class in the profile and task part of the seminar.
2. profile and task part – concerns discussion of particular aspects of writing a dissertation that result from the subject matter of the classes – both methodology and tools oriented aspects.

LEARNING GOALS

1. Preparing students to choose his/her dissertation topic through presentation of selected topics from respective departments of WSCS.
2. Writing Master's dissertations within the area assigned by the name of seminar group. The Master's dissertation should include a creative element and bring certain new values or generalizations into the design and implementation practices. The subject matter of the seminar forms a logical structure of the hypothetical layout of Master's dissertation and aspects that should be taken into consideration in this standard of diploma dissertations.

DESCRPTION OF LEARNING OUTCOMES

DESCRIPTION OF LEARNING OUTCOMES ON A SUBJECT LEVEL	ASSESSMENT METHOD OF LEARNING OUTCOMES (ASSESSMENT FORM)
Knowledge	
1. Student knows the research topics in particular departments of WSCS. He/she knows the conditions	Dissertation topic Dissertation

necessary to write a dissertation within a specific department.	preparation
Skills	
1. Student is able to assess the compliance of his/her own areas of interests with the professional development proposals offered by the School.	Dissertation topic Dissertation preparation
2. Student is able to begin and complete his/her Master's dissertation	Dissertation topic Dissertation preparation
Social competence	
1. Student is competent in the choice of his or her own diploma path.	Dissertation topic