

UNDERGRADUATE PROGRAMME

Calculus AM

The aim of the course is to provide the students with a good understanding of the basic ideas of calculus in real numbers, including sequences, functions of one or two real variables, derivatives, partial derivatives and their applications (as location of extrema, the L'Hospital's rule, Taylor polynomial). It covers the notions of the indefinite and definite integral double and iterated integral with applications such as the area and volume of solids.

Also are presented the connections of Mathematical Analysis with Computer Science such as algorithms, artificial intelligence, robotics, statistical data analysis, numerical analysis and computer graphics.

Fundamentals of Java Programming PPI

Fundamentals of programming in Java language: variables, literals, operators, control flow instructions, iterations, arrays, expressions, strings. Notions of type, class, object will also be covered, as well as introduction to object-oriented programming. Some more advanced elements will also be introduced, such as, e.g., exception handling, input/output operations, text analysis, sorting, searching, recursion.

Computer Techniques and Architecture TAK

This lecture aims in presenting to students foundations of computer science. Programming concepts as well as functioning, architecture and logical organization of computers and computer systems are addressed. The presentation is rooted in the history of computer science, exposing the development of concepts.

Introduction to Management WDZ

The main objective of the course is to acquaint students with basic management concepts and terms. Except theoretical concepts, students will participate in workshops, analyze case studies and prepare assignments enabling the practical use of acquired knowledge.

Introduction to Information Systems WSI

The aim of this course is to introduce students into the world of information systems. There will be presented the most important ideas and challenges the students will face while taking consecutive courses on information systems development. The additional goal to be achieved during laboratory classes mainly, is using of basic tools applied in work with computer and special emphasis on the best practices in this field. The course includes three main topics: databases, software engineering and use of computers.

History and Culture of Japan HKJ

The lectures contain topics from Japanese history, culture and developments in technology and economy.

Linear Algebra with Geometry ALG

The aim of the course is to provide the students with a good understanding of the important concepts of linear algebra and the ability to use them. That is to manage with the main functions of complex variables, matrices and determinants, perform Gaussian Elimination, find the inverse matrix, solve systems of linear equations and be able to interpret them in terms of matrices, linear combinations of vectors and linear transformations, distinguish linear spaces, find coordinates relative to different bases, use linear transformations and find their matrices relative to different bases, determine eigenvectors and eigenvalues, diagonalize a matrix, use the dot product to find orthogonal bases.

Connect Linear Algebra to other fields especially those appearing in Computer Science such as computer graphics, data bases, algorithms, running time estimates etc.

Discrete Mathematics MAD

The aim of the lecture is to give the students a wide general view of the fundamental notions concerning algebra of sets, algebra of relations, propositional and predicate logic, power of sets, algebraic structures, induction, recursion, theory of combinations, some elements of probability theory and elements of graph theory. Emphasis will be put on providing a context for the application of the presented notions within the computer science.

Relational Databases RBD

The main goal of the courses to get student's knowledge about database topics with special emphasis on relational databases, basic relational database notions, both for conceptual level (entity, attribute, relationship, key, foreign key) and for physical level (table, referential constraints). Next goal is to achieve student's ability to use CASE tools for data modeling and basics of SQL database language concerning DML and DDL statements. Final goal is to develop student's social competencies such as lifelong learning, role of informatics, professional ethics and responsibility.

Object Oriented-Programming and Graphical User Interface GUI

The course introduces advanced object-oriented techniques on the example of the Java programming language. In the second part of the term we deal with graphical user interface programming utilizing this way the skills gained during the first part of the term.

Programming in C and C++ PJC

The aim of the lecture is to teach the students the C++ programming language as a modern language which allows programmers to write fast, effective software. All aspects of the language will be presented, with emphasis on its standard, platform independent features. Both

procedural and object oriented approaches to programming will be covered. Students will also learn how to effectively use the tools provided by the standard library; some elements of software engineering will also be discussed.

Operating Systems SOP

Lectures present basic concepts and techniques concerning operating systems, including: operating system structure, various resource management techniques, processes, synchronization problems and methods, virtual memory and file system implementation. Discussion of example operating systems completes the presented material. During the laboratory classes, students can also gain the practical knowledge of Linux/Unix environment, learn writing shell scripts and elements of system programming.

Algorithms and Data Structures ASD

The purpose of the lecture is to present fundamental algorithms for different class of real life problems as well as to introduce data structures and several algorithmic areas including verification, testing and complexity of algorithms.

Statistical Data Analysis SAD

- Graphical techniques for presentation qualitative and numerical data. Summary statistics. Probability densities related to histograms.
- Probability, conditioning, independence, Bayes' theorem.
- Random variables, their distributions and parameters, special distributions, sequences of random variables, central limit theorem.
- Basic sample statistics and their properties, confidence intervals, parameter tests for means and variances for one and two populations, nonparametric tests – Pearson's chisquared test and test of independence, simple linear regression.

Database Systems SBD

The course “Database systems” is a continuation of the course “Relational databases”. The main goal is to get student's knowledge about advanced features of the SQL language and its extensions for specific systems, architecture and administration of database management system and database optimization. The second goal is to achieve student's ability to work with data warehouses and OLAP applications, object-relational databases, data integration and XML. Final goal is to develop student's competencies such as self-presentation and teamwork.

Digital Systems and Basics of Electronics SYC

The aim of the course is to present knowledge about the digital system architecture and design on different levels of functionality. The subject starts with introduction to basic of electronics, like passive and active elements, electrical measurements, and the most elemental electronic circuits. The logic gate is introduced in terms of building, functionality and standards. Design and optimization methods of combinational and sequential circuits are discussed like K-map optimization and state machine design. Finally, the architecture and main blocks of

microprocessors and controllers are presented with applications, eg. , ADC, PWM, ports, event handling and communication standards.

Universal Programming Techniques UTP

Course covers some fundamental programming methods:

- generics,
- elements of functional programming and streams,
- advanced interactions collections' and input-output operations,
- reflection and component programming,
- modern concurrent programming tools,
- application localization and internationalization,
- XML processing,
- database programming,
- design patterns.

General concepts are explained with Java samples.

Computer Networks and Network Programming in Java SKJ

The course presents principles of contemporary computer and telecommunication networks, especially IP networks, using the Internet as an example. Basic principles of switching (packet, channel and virtual channel) and multiplexing are presented. The course introduces a layered network model and uses this model to structure the discussion of computer networks, which proceeds from the application layer to the link layer. Students learn about communication protocol design on the examples of HTTP, SMTP, FTP and DNS and about programming of network applications using sockets. Methods of reliable communication and congestion control in the transport layer are presented on the example of the TCP protocol. Students learn about packet switching using IP routing as an example. Multiplexing mechanisms are studied on the example of link layer protocols (Aloha, CSMA/CD, 802.11). Students learn about principles of local area network design and about basic media used in telecommunication networks. The course also presents basic mechanisms of information security in computer networks, including methods of assuring confidentiality, authentication and data integrity through cryptography.

Artificial Intelligence Tools NAI

The basic tools and algorithms to build intelligent systems are introduced with emphasis to its application, features and limitations. Discussed in details: neural networks, decision trees, fuzzy systems, genetic and evolutionary algorithms, but also data preprocessing algorithms.

Fundamentals of Python Programming PPP

Lectures and practical classes are dedicated to demonstrate the Python programming language as a universal language used in many areas. Students will become acquainted with an approach to programming substantially different than they know after studying the languages from the C++/Java/C# family. It will enrich their general knowledge of programming and teach them a language used virtually everywhere and of great area of applications.

Software Design PRI

The aim of the lecture is to introduce the student into object-oriented approach in the context of software analysis and design. The lecture focuses on presentation of three basic aspects of object-oriented approach. 1st – the most important object data model concepts, which create the basis in object languages and object methodologies supporting the software development process, are presented; 2nd – some techniques, useful for analysts and designers, are introduced; 3rd – the Unified Modeling Language (UML), which is the industry-standard language for specifying, visualizing, constructing, and documenting the artifacts of software, is presented. The knowledge of all three above-mentioned issues makes possible to appreciate advantages of object-oriented approach in software analysis and design.

Legal Foundation of Business PPB

The minimal scope of the knowledge and skills for students who have finished the course in Legal Foundation of Business consists of practical aspects of legal acts related to commercial activity, especially the Law on Business Activity, Law on National Commercial Register, Commercial Code and Civil Code. Moreover the student should be familiar with the institutions connected to business activity. It is required that the students know the rules of establishing and running a business activity of the natural person as well as rules of the foundation, management and liquidation of companies under the Commercial Code.

Multimedia MUL

The aim of the course is to explain fundamentals of computer multimedia technology. The program of the course comprises a description of basic techniques of image and sound engineering, algorithms of compression and processing of multimedia data, principles of auditory and visual perception, and also methods of working and creation of multimedia applications and technical design of audio-video computer interfaces, methods of digital acquisition and processing of sounds and images underlying modern multimedia technology. Moreover, the course program includes the following topics: voice man-machine interface, sound synthesis, audio and video signal coding and compression, multimedia databases and some selected multimedia applications.

Computer Graphics GRK

Lecture will focus on basics of rendering computer graphics with emphasis on real time 3D graphics. More prominent topics include: basics of physiological mechanism of vision, methods of generating 2D and 3D graphics, optimizations of rendering algorithms for 3D environments, physics simulations and methods for space dividing in modern computer games.

Software Engineering BYT

The course aims to familiarize students with basic issues of software engineering, including the phases of software development, and methods of improving the quality of software. The lecture covers various aspects of software engineering and is organized according to the successive phases of the software life cycle. Phases are discussed: a strategy for gathering requirements,

analysis, design, construction, testing, installation and maintenance. During the course addresses the issues of good and bad practices in software engineering, requirements engineering, design patterns, use of the database layer, including relational databases and object-oriented, model-based information systems services (SOA) and cloud computing). Also discussed are issues such as documenting the results of the project and produced software products, quality management software, software measurement, software testing CASE tools, project management, programming features and configuration management software.

Students learn in the class CASE tool supporting the work of a team of software engineering: IBM Rational RSA software.

Software Project Management ZPR

The course describes various aspects of software project management: selecting a project team, managing domain processes, defining the goal and scope of the software project, identifying the tasks and activities, choosing an organizational form, scheduling the work, risk management, project tracking and control, software quality assurance, software configuration management. This course describes in basic modern software project management methodology (PMBOK, Prince 2, MSF, UP, XP, SCRUM), IT service management methodology (ITIL, MOF), and IEEE standards used in software project management. The course provides simple, practical examples which reflect the theory.

Design and Analysis of Information Systems MAS

The course is devoted to practising the skills that are necessary for transition from a conceptual model (the product of the analysis and requirements specification phase in software development life cycle) into a specific implementation environment, either object-oriented or relational. Students learn some conceptual features that have no direct counterparts in a chosen implementation environment (actually Java or MS C#). Some rules regarding designing (usability) and implementing user interfaces and utilization of software frameworks are also presented. The lectures are supported by the implementation including data management, application's behaviour and creating simple GUIs. Requirement specification and static analysis should be done along with teaching the course "Object Modelling Techniques in Software Analysis" (PRI). The size of a project, that each student has to do on their own, is limited to between 10 and 15 UML classes.

Information Systems Security BSI

The aim of the course is to obtain competences and skills in the field of issues related to the security of information systems. Currently, the most valued document on the market confirming this knowledge is the CISSP (Certified Information Systems Security Professional) certificate issued by the international organization ISC2. The knowledge and skills required for the certification exam are divided into thematic domains: ICT security and network security, Access Control, Information Security and Risk Management, Architecture and Security Design, Application Security, Operational Safety, Physical Safety of the Environment, Management business continuity, cryptography and law, regulations, conduct. The material of the BSI subject covers the main security domains, with particular emphasis on Web application security,

computer network security and cryptography. During practical laboratory classes, practical knowledge regarding network security and cryptography will be discussed.

Human-Computer Interaction ICK

The aim of the course is to provide students with the necessary theoretical and practical knowledge related to the basic aspects of human-computer interaction (HCI), creating graphical user interfaces (GUI), and in particular with the methods of user-centered design (UCD). The main idea is to present in practice the elements of the process of creating interactive products that provide a high level of user experience (UX). During the classes, students work in groups and design prototypes of mobile applications based on the concepts they have created. The design process includes, among others analysis of design requirements, determining the characteristics of user needs, creating concept sketches, designing and prototyping graphical user interfaces (low/high fidelity) in accordance with the guidelines and design patterns for selected operating systems, evaluation and usability testing of the solutions produced, as well as development of conclusions and reports resulting from the conducted research. Issues related to the accessibility of websites and the perception of multimedia data will also be discussed.

ELECTIVE COURSES

Fundamentals of Computer Simulations PSM

The goal of the lectures is to make the students acquaintance with the fundamental methods and problems of the computer simulations in many different areas of the human being activities. The very big number in the material and social spheres may and should be studied with the help of computer simulations and the solutions should be discussed before the final decisions will be undertaken.

The separate and huge sphere of the applications of the computer simulations are multimedia and computer graphics where the need of the proper representations of the motion of arbitrary objects should be realistic and in accordance with laws of nature (unless the conscious decisions of the simulation authors are different). The computer simulation in itself is the culmination of the preceding actions, i.e. preparing the model of the phenomenon or the process, transformation the theoretical model into the mathematical model or into the algorithm of processes following the every iteration step, as it takes place e.g. in the case of the cellular automata programing, and finally into the numerical model. The actual presentation of the simulation should allow to broaden student's knowledge about the studied problem.

The lectures are focused on practical skills. During the laboratory classes the programing applications devoted to computer simulations will be demonstrated. Students will perform miniprojects for each of the topics.

Database Applications APBD

The lecture is devoted to issues related to the construction of applications using relational databases. Classes are conducted in C# using the .NET Core platform.

Distributed Programming Technologies TPO

The subject covers modern programming techniques in distributed environments. The main objective of the course is to learn the creation of scalable and efficient servers, web applications, and network APIs using the currently most popular framework for Java application development - Java Spring, along with components such as dependency injection container, inversion of control (IoC), Spring MVC, Spring Data, Spring Security, and many others.

Additional topics will introduce tools and technologies used in typical business applications:

- Hibernate
- JPQL
- Liquibase
- H2, MySQL
- Bean Validation
- Docker
- Most important design

Classes will be dedicated to the practical implementation of selected distributed programming techniques in projects.

Methods of Knowledge Engineering MIW

In its beginnings, knowledge engineering dealt almost exclusively with expert systems, i.e. systems in which the knowledge of experts in a given field was usually represented in a rulebased knowledge base, and processing was limited to logical inference. Today's approach requires treating knowledge engineering as a separate field related to the creation of knowledge bases for processing knowledge by computer systems. Modern knowledge engineers strive to create solutions that enable not only the use of knowledge in reasoning systems, but also the acquisition of new knowledge from various resources. There are three basic branches of knowledge engineering:

- artificial intelligence and machine learning,
- engineering of extracting hidden knowledge from large data sets - expressed in the form of models useful for the user (logical, statistical and decision models, etc.)
- knowledge extraction expressed in verbal form.

The MIW course discusses various approaches to knowledge engineering, giving an overview of basic theories and methods in the field. Practical exercises allow students to get acquainted with the technical aspects of the acquisition and use of knowledge.

Basis of Machine Learning PUM

The aim of the course is to develop the ability to solve practical business problems with the use of machine learning techniques and methods. After the course, the student should be able to identify the type of machine learning problem for a given business problem, recommend an appropriate class of algorithms for it, and design a process for training and evaluating machine learning models. In particular: obtain data, prepare them for modeling, train models using many available algorithms and assess the quality of models.

Business Process Engineering IPB

The course aims to familiarize students with the problems of border business and IT, in particular the identification, documentation and business process modeling and the use of IT tools to support workflow processes. During classes, students learn the principles of documenting business processes in BPMN notations, process modeling using Petri nets and process algebra elements. Student should understand the workflow systems and be able to plan and program the workflow process in the selected tools. Students should also be able to use leading-edge software for business process modeling and simulate processes.

AutoML Runtime Environments SUML

The course aims to develop the ability to prepare programming environments dedicated to Machine Learning projects, both at the stages of data acquisition, training, model evaluation,

and their deployment in production systems. Students should also learn the practical aspects of running their solutions on external servers (including dedicated Cloud ML solutions) and using already pre-trained models: connect them to their applications and publish for the end-user. The course is supplemented with essential information about solutions that automate the design and training of machine learning models (so-called AutoML systems).

Automata and Grammars AUG

The course covers lexical and syntactic analysis, tools supporting development of lexical and syntactical analyzers (Lex, Flex, JFlex, Yacc, Bison, JCup), and necessary background in the theory of formal languages and automata, namely: regular languages and context-free languages.

Machine Learning Operations and System Architectures ASI

The course aims to develop project management skills in Data Science projects, design artificial intelligence system architectures, and make practical use of MLOps methods and tools. After the course, the student should be able to plan the Data Science project, design a high-level architecture of the AI solution (including data layers, their processing, and interaction with the end-user), and deploy trained models in production environments. Moreover, (s)he will know how to design and implement an ML system for maintenance, continuous training, and model development using the best MLOps solutions.

Content Management Systems CMS

The goal of the lecturing series is introducing the audience into basic issues of the content management using web portals. Students will learn different requirements regarding Content Management Systems implemented as web applications. A hands-on aspect, both lectures and labs, will be presentation of existing popular solutions. Thanks to that approach, the attendees will be able to choose the right tool to their needs. There are also plans of discussing a case when existing solutions are not enough and a dedicated system should be implemented. Next lecture concerns content configuration management and workflow management. In the following the lectures concern CRM (Customer Relationship Management) and SCM (Supply Chain Management). Another topic which will be presented is searching for contents taking into account their variety (text, images, videos, etc.) and such a presentation which make them easily recognizable by web search engines. During the semester, small student groups implement a system related to the content management.

Basics of Bioinformatics PBIO

The course is designed to develop firstly the skills, secondly the knowledge, of students, which will enable them to function in interdisciplinary areas combining computer science with biology, pharmacy and medicine. The growing demand for specialists who, in addition to purely IT knowledge, are able to understand and interpret data from biological experiments, indicates the need to create this type of mixed subjects. Participants gaining practical knowledge of the basics of bioinformatics will be able to be valuable members of teams wherever there is a need to create solutions for the needs of medicine, pharmacy,

agrobiotechnology, etc. Due to its hourly format, the subject is an introduction to bioinformatics and is primarily intended to provide an opportunity to recognize the industry and the opportunities facing the future IT professional.

The didactic process will be supported by gamification elements.

SPECIALIZATION-SPECIFIC COURSES

Internet Technologies (specialization codes: A, IO, E,G) TIN

The lecture is focused on the core standards and technologies for development WWW applications. Static, active and dynamic webpage technologies are presented, based on prior brief introduction on the Internet protocols in their aspects important for a Web programmer. Patterns, frameworks and security considerations for WWW applications are outlined. Markup languages, XML in particular, are given a significant coverage including their validity, wellformedness, schema definition, programming interfaces, querying and transformation. The application-to-application integration is covered in the context of the Service Oriented Architecture (SOA) concept, and the main standards for Web Services technology are introduced.

Advanced Computer Networks (specialization codes: B, H, C) ZSK

The course is an overview of advanced networking technologies that concentrates on three areas: multimedia communication and Quality of Service in computer networks, computer network management, and wireless networks. The course presents multimedia communication protocols in IP networks (RTP, RTSP, SIP) and methods of designing applications that use multimedia communication. Students learn about Quality of Services in computer networks, ATM network technology, IP DiffServ and MPLS technologies. Computer network management is studied, especially protocols and systems used in IP network management (SNMP, LDAP). The course presents cellular network technologies (GSM, UMTS, LTE, 5G) and satellite networks. Students learn about protocols used in wireless local area networks (Bluetooth, Wi-Fi 1 – Wi-Fi 6). Students also learn basic IP routing configuration on CISCO routers and gain a deeper knowledge of computer networking through simulation using the ns2 network simulator.

Intelligent Control Systems (specialization codes: D, F) ISS

The course ISS is aimed at providing students with the basic knowledge concerning control systems both in the classical case and in the case of reasoning under uncertainty (the intelligent control theory). Classical control theory rudiments serve as a motivation for the more advanced intelligent methods. The latter do encompass cognitive methods (neural networks), rule based systems (fuzzy, rough systems), information filters etc. A separate thematic group is formed by methods related to agent control like localization or map forming.

Database Administration (specialization codes: A, IO) ABD

The lecture is aimed on subjects regarding administration of databases. It is showed using an example of Microsoft SQL Server as well as other database systems. The lecture's programme covers database installation and configuration, describes physical data organization on server disks as well as subjects concerning server security. It also gives knowledge about files and backup management, accounts and permissions and describes a sphere of data import/export. Performance problems, parallel work of many users as well as distributed databases are also being presented.

Advanced Operating Systems (specialization codes: B, C) ZSO

The course provides an extension to the students' knowledge of operating systems. Particularly, it concerns an inter-process and inter-thread communication and synchronization mechanisms, network communication and distributed processing. Moreover, distributed file system mechanisms are presented together with examples of distributed operating systems. Designing methods of the distributed applications will be presented, including concurrency patterns theory. Advanced system applications instrumenting, monitoring and debugging also will be discussed.

Machine Vision (specialization codes: D, E, F) WMA

Methods of reasoning apply in many contexts like reasoning about choice of a path to the goal, about choice of a decision value (like voting), about choice of a strategy (games with perfect information, games of strategy, random games), localization detection. Those methods are applicable to a single agent as well as to teams of agents. In the latter case an additional factor are protocols of communication and consensus seeking: a good example here is Robotic Soccer in which a team of few robots takes part in a play of soccer. A nice environment for this scenario is the ROS + Stage system. Classes using this system are an essential and large part of practical lectures. They are essential for robotics students, for multimedia students interested in simulation and visualization techniques and for students of information systems. Also important are classes about methods of localization of an object by a single agent as well as by a team of agents.

Programming for Mobile Devices (specialization codes: G, H) PRM

Lectures and practical classes are dedicated to demonstrate and learn mobile device programming techniques used in live Android ecosystem.

„Mobile Programming” subject is being dedicated to present programming methods of the most popular programming language. During lectures students will be able to learn about devices evolution which took place within last decade, problems faced by programmers and solutions found. Presented knowledge could be divided into three subjects: fabrication of applications, devices communication and databases usage.