AKADEMIA ŁOMŻYŃSKA

Erasmus+

Field of Study: Computer science

Offered courses for the academic year 2025/2026, **winter semester**, with descriptions

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Semester 1

Basics of Programming

The main aim of the course is to familiarize students with the basic concepts of programming in C and to acquire practical skills to create software in C and C++.

The course presents information for people learning C and C++ as first programming language. Course will give a full introduction to all of the core concepts in the C and C++ programming language.

Topics:

- C and C++ Introduction
  - Variables & Constants, Data Types, Input/Output, Operators
- Flow Control
- Functions
  - Programming Functions, User-defined Functions, Recursion
- Programming Arrays
  - Arrays, Multi-dimensional Arrays, Arrays & Function
- Programming Pointers
  - Pointers, Pointers & Arrays, Pointers & Functions,
- Programming Strings
- Structure And Union
- Programming Files

Semester 3

Algorithms and Data Structures

The main aim of the course is to familiarize students with the basic concepts of using data structures and algorithms in programming. It provides guidance on how to implement basic data structures from scratch: arrays, linked lists, graph, trees and then use the structures to implement algorithms such as sorting, searching, etc. using C++ or Java language.

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Topics:

- Simple data structures: Arrays, Linked Lists
- Abstract data types: Stacks, Queues, Heaps
- Trees: Binary Search Trees, Balanced Binary Trees, B-Trees
- Simple Sorting algorithms: Bubble Sort, Selection Sort, Insertion Sort
- Quick Sorting algorithms: Shell Sort, Heap Sort, Merge Sort, Quick Sort
- Algorithms designing methods: Divide and conquer, Recursion, Dynamic programming
- Graph algorithms: Dijkstra algorithm

Introduction to Numerical Methods

The course aims to present numerical analysis topics and the basic numerical methods, implemented in standard programs. In each case there will be discussed the applicability of the methods, conditions of convergence (for iterative methods), approaches to estimate the error of computations and effective algorithms of correcting the accuracy.

Topics:

- Linearization of nonlinear systems of equations
- Direct methods of solving the linear systems of equations
- Iterative methods of solving the linear systems of equations
- Iterative methods of solving the nonlinear equations
- Orthogonalization of vectors
- Polynomial interpolation
- Numerical integration
- Random number generators and their applications
- Monte Carlo Methods

Basics of Artificial Intelligence

The aim of the course is to outline the basic methods and techniques of artificial intelligence and to put them in an algorithmic context. The course also equips students with the skills to use artificial intelligence tools in forecasting, classification, approximation, estimation, and logical inference.

Topics:

- Programming in Matlab. Interface. Variables. Vectors (single row or single column matrices). Two-dimensional matrices. Array and array operations.
- Basic functions and constants. Relational Operators. Logical operators and functions.
- If statement. Switch instruction. The for and while loops.
- Creating m-files. Scripts.
- Features. Sub-functions.
- Graphics in Matlab. 2D graphics
- 3D Graphics. Graphs of functions.

- Simulink - modeling of dynamic systems. Mathematical model. Simulink
- Simulink - examples of models of dynamic systems
- Selected numerical capabilities of the Matlab package
- Working with Toolboxes: Neural Network, Genetic Algorithm.
- Modeling KAG systems in Matlab.
- Classification of raster objects and space points using SSN.
- Application of SSN in approximation tasks.
- Modeling SSN systems in Matlab.

Programming Microcontrollers

The main objectives of the course are presentation of the scope from the basics of construction and programming of microcontrollers, learning to create simple and complex electronic circuits controlled using a microcontroller and the practical use of the microcontroller in everyday life. Classes take place on the basis of the Arduino family of microcontrollers.

Topics:

- Preparation of microcontroller device. Installation of the environment. Uploading the first program.
- UART communication. Serial transmission. Global and local variables in Arduino.
- ADC. Servos. PWM. Voltage measurement by means of an A/D converter.
- Arduino external libraries.
- Servos.
- Control of DC motors.
- LCD Displays. I2C communication.
- Sensors. Measuring humidity, distance, temperature.
- Create charts with the Arduino and its built-in tool.
- Interruptions. Arduino interrupt handling.

Visual Object-Oriented Programming

The aim of the course is to gain knowledge about working in RAD environment (rapid application development using visual tools). Rapid Application Development is a methodology of designing information systems, focused on rapid creation of a system prototype, susceptible to further development in an iterative design cycle. RAD is a response to structured design and programming methodologies. During the classes Windows Forms library of Visual Studio environment for C# and Visual Basic language are used.

Topics:

- Overview of Visual Studio environment, principles of creating projects, working with debugger.

- A console application that displays the annual calendar, use of packages, string operations String class.
- Digital clock, using ProgressBar controls to represent the passage of time. Using Timer component, sample application in Visual Basic or C# language.
- Handling events generated by user interface elements, working with basic controls, common properties.
- Complex class implementation for basic operations on complex numbers, Mandelbrot set drawing application
- Multithreaded implementation of sorting algorithms. Mergesort, Insertionsort
- Multithreading in GUI applications, delegation, synchronization.

Advanced Computer Networks

During this class students will learn about Switching, Routing, and Wireless Essentials (SRWE). That covers the architecture, components, and operations of routers and switches in small networks and introduces wireless local area networks (WLAN) and security concepts. Students learn how to configure and troubleshoot routers and switches for advanced functionality using security best practices and resolve common issues with protocols in both IPv4 and IPv6 networks.

Topics:

- Configure VLANs and Inter-VLAN routing applying security best practices.
- Troubleshoot inter-VLAN routing on Layer 3 devices.
- Configure redundancy on a switched network using STP and EtherChannel.
- Troubleshoot EtherChannel on switched networks.
- Support of available and reliable networks using dynamic addressing and first-hop redundancy protocols.
- Configure dynamic address allocation in IPv6 networks.
- Configure WLANs using a WLC and L2 security best practices.
- Configure switch security to mitigate LAN attacks.
- Configure IPv4 and IPv6 static routing on routers. Configuration, management of network devices

Database Systems

The aim of the Database Systems course is to familiarize the student with the theoretical foundations of databases using Oracle database system.

Topics:

- Normalization requirements of logical schemes in the process of creating a relational database
- Query language used in a relational database.
- Basics of creating, modifying and filling in new objects in database.

- Various types of queries in SQL.
- Practical knowledge and the ability to select the right query.
- Basics of creating new tables and views
- Extracting data from an Oracle database.
- Performing modifications to object structures and entering, deleting and modifying data.
- Overview of the transaction processing process.

Semester 5

Technologies of Internet Application Manufacturing

The aim of the course is to familiarize students with technologies and methodologies of web application development by discussing their advantages and disadvantages. In addition, the specialist lab will cover the basic problems of designing Internet applications, in which students will use Python, Javascript and the Django framework.

Topics:

- Introduction to HTML and CSS
- Introduction to the Python language
- Introduction to the Django tool, project configuration
- Views and templates
- Creation of databases and models
- Dynamic resources and user files
- Session and authentication mechanism
- Introduction to Javascript
- Create pages that don't need refreshing
- Unit test implementation in Django
- Creating a Rest compliant application programming interface
- Dynamic PDF and image generation
- Publication of applications on the web

Advanced Software Engineering

The aim of the course is to provide knowledge on advanced software engineering techniques. Advanced UML diagrams will be considered. These will be design diagrams, i.e. state diagrams - complementary to class diagrams, and diagrams of complex structures. Another type will be implementation diagrams, used at the stage of project implementation and placing it on hardware resources. Design patterns in class diagrams will also be discussed. The issue of using UML diagrams in team projects will also be presented.

Topics:

- Components diagram
- Packets diagram
- State machine diagram
- Implementation diagram
- Diagram of complex structures
- Use of the known diagrams in team projects
- Design patterns

Security of Computer Networks

The course provides a next step for individuals who want to enhance their networking skill set and help meet the growing demand for network security professionals. Provides an introduction to the core security concepts and skills needed for the installation, troubleshooting, and monitoring of network devices to maintain the integrity, confidentiality, and availability of data and devices.

Topics:

- Modern Network Security Threats
- Securing Network Devices
- Authentication, Authorization and Accounting
- Implementing Firewall Technologies
- Implementing Intrusion Prevention
- Securing the Local Area Network
- Cryptographic Systems
- Implementing Virtual Private Networks
- Implementing the Cisco Adaptive Security Appliance (ASA)
- Advanced Cisco Adaptive Security Appliance (ASA)
- Managing a Secure Network

Multimedia

The course aims to present information about basic algorithms of coding and processing multimedia and their use to create multimedia applications. The laboratory covers the scope of creating multimedia applications containing audio, images and video presenting and processing methods using C# or Java language.

Topics:

- Audio recording and processing. An application to play the sound.
- Audio coding and compression methods. Audio signal transcoding.
- Compressed audio formats. Visualization of the sound spectrum using the Fourier transform.
- Image viewer.
- Image file editor

- Image processing algorithms.
- Video playback and processing. Software implementation of selected issues in the field of digital video processing.
- Transmission of multimedia content over the Internet.

Team project I

During the classes students develop a project of an information system solution to a given problem with particular emphasis on data exchange between an application and a database.

The resulting system must consist of:

- databases on the server (MySQL/Postgress/MsSQL)

and at least one of the following three subsystems:

- desktop application (Windows/Linux/iOS),
- web (internet) application (PHP/ASP.NET),
- mobile application (Android/iOS/Tizen/Windows Mobile/Android Wear).

Teamwork is an important part of the class. Students must demonstrate the ability to work in a group, delegate tasks, exchange information and mobilize each other to work.

As part of the project activities, the student will gain skills by completing the following:

- development of project assumptions, description of the created system and its functionality,
- definition and division of tasks in the team
- development of a Gantt chart
- analysis of literature and existing solutions in the field of the created project
- selection, installation and configuration of IT tools necessary to implement the project.
- development of protocols for information exchange between subsystems.
- development of a database structure.
- user interface development
- development of algorithms for application operation
- implementation of an IT solution
- development of project documentation
- presentation of the final result

Methods and Techniques of Artificial Intelligence

Course offered on the specialization: software systems. This course is a continuation of the Basics of Artificial Intelligence topics. The course is conducted using the Matlab software package.

Topics:

- Programming in Matlab. Selection methods based on adaptation function - random selection method with repetition/ roulette wheel.
- Practical implementation of genetic algorithms. Linear scaling.
- Advanced techniques and operations. Scaling by the σ-cutoff method.
- Advanced techniques and operations. Logarithmic scaling.
- Practical implementation of genetic algorithms. Types of crossovers in genetic algorithms.
- Basic genetic operators: one-point and two-point crossing. Mutation.
- Advanced techniques and operations. Evolutionary strategy (1+1).
- Project 1 Study of parameters Population Size, Generations on the result of optimization using GA function.
- Project 2. Study of Fitness scaling, Selection parameters on the result of optimization using GA function.
- Project 3. Goal function optimization with genetic algorithm (GA).
- Project 4. Goal function optimization by genetic algorithm (GA) with hybrid function.
- Project 5. Goal function optimization with pattern search (PS) algorithm.
- Application of AG to solve specific problems as part of the student's own work (project completion and credit).
- Demonstration of the operation of genetic algorithms (AG) for solving optimization problems