COMPUTER SCIENCE, UNDERGRADUATE STUDY PROGRAMME, FIRST BOLOGNA CYCLE
COURSE DESCRIPTIONS

COMPULSORY COURSES

COMPULSORY COURSES FOR THE 1ST YEAR OF STUDY

Course name: **MATHEMATICS I - ANALYSIS I**
Number of ECTS credits: **6**

Content:
- The natural numbers. Rational numbers. Real numbers. Complex numbers.
- The sequence of real numbers. Limits and accumulation points. Cauchy condition. Upper and lower limit. Monotone sequences. Bolzano-Weierstrass theorem.
- Series. The convergence criteria. Absolutely and conditionally convergent series.
- Functions of real variables, even and odd functions, periodicity. Limits of functions, left and right limits. Continuity. Continuous functions on closed intervals limited. Bisection method for finding zeros.
- The elementary functions. Cyclometric functions.

Course name: **MATHEMATICS II - ALGEBRA I**
Number of ECTS credits: **6**

Content:
- Vectors, analytic geometry in space.
- Matrices. Types of matrices and basic operations with matrices. Rank of a matrix. Inverse.
- Systems of linear equations. Matrix interpretation and theorem of solvability. Elementary matrices, Gauss method. Determinants. Cramer's rule.

Course name: **THEORETICAL COMPUTER SCIENCE I – DISCRETE STRUCTURES**
Number of ECTS credits: **6**

Content:
The course will cover topics that might include (but are not restricted to) any of the following according to the needs and development of the subjects covered:

- Fundamentals of mathematical theory, propositional calculus, truth tables, predicate calculus.
- Formal languages.
- Basic concepts of mathematical logic.
- Ways of describing sets. Basic relations between sets, basic operations on sets or families of sets. Power set. Relations. Graphs. Equivalence relations. Partial and linear ordering. Lattices and Boolean algebra. Well-ordered sets. Functions. Special types of functions. Categories.
- Finite and infinite, countable and uncountable sets.
- Cardinal and ordinal numbers. Peano arithmetic, mathematical induction.
- NBG and ZFC systems of axioms of set theory. Axiom of choice. Zorn's lemma.
- Fundamentals of symbolic computation (Mathematica).

Course name: **THEORETICAL COMPUTER SCIENCE II – FORMAL LANGUAGES AND COMPUTABILITY**
Number of ECTS credits: **6**

Content:
The course will cover topics that might include (but are not restricted to) any of the following according to the needs and development of the subjects covered:

Finite automata and regular expressions:
- Computation model, finite automaton – DFA and NFA
- Alphabet, language, regular expression/language
- The relation between DFA, NFA and regular expressions
- Using FA to solve problems
- RE pumping lemma, non-regular languages

Grammars, context (non)free languages and stack automata
- Grammar, derivation tree, attribute grammar
- Context-dependent and context-free languages, stack automaton
- Grammar normal forms: Greibach, Chomsky (CNF)
- Transforming grammars into CNF
- CYK algorithm
- Pumping lemma for CFG
- Operations on languages (intersection, union …)

Turing machines and their languages:
- Turing machine and its derivations, RAM
- Church-Turing thesis
- Recursively enumerable languages, Chomsky hierarchy
- Unsolvable and undecidable problems, the stopping problem, Rice theorem and PCP

Introduction to the theory of complexity:
- P and NP – relation between them
- Problem translation, NP completeness
- NP complete problems

Course name: **PROGRAMMING I**
Number of ECTS credits: **6**

Content:
The course will cover topics that might include (but are not restricted to) any of the following according to the needs and development of the subjects covered:
- Basic building blocks of a computer program.
- Basic syntax of the programming language Java:
  Variables, types and expressions. Basic I/O operations. Decision statements. Control structures. Functions and parameters. Programs. Structural decomposition.
- Basic data structures:
  Simple types. Arrays. Records. Characters and strings. Data representation in computer memory. Memory allocation. Linked structures. Stack. Queue. List. Tree.
- Algorithms and problem solving:
  What is an algorithm? Problem solving strategies. The role of algorithms in problem solving. Algorithm implementation strategies. Debugging. Recursion – recursive functions, divide-and-conquer principle, backtracking, implementation of recursion.
- Programming languages overview:
  Types of programming languages. Flow control. Functions. Subprograms. Namespaces.
- Declarations and types:
  Types. Declarations of types. Safe typing. Type checking. Subtypes. Classes. Polymorphism
- Abstraction mechanisms:
  Data abstractions. Simple types. Composite types. Flow abstractions. Subprograms and functions. Abstract data types. Objects and classes. Patterns. Modules.

Course name: **PROGRAMMING II – CONCEPTS OF PROGRAMMING LANGUAGES**
Number of ECTS credits: **6**

Content:
The course will cover topics that might include (but are not restricted to) any of the following according to the needs and development of the subjects covered:

- Introduction
- Lambda calculus
- Syntax
- Basic structures
- Functional languages
- Imperative languages
- Types
- Modules
- Objects and classes

Course name: **SYSTEMS I - HARDWARE**
Number of ECTS credits: **6**

Content:
The course will cover topics that might include (but are not restricted to) any of the following according to the needs and development of the subjects covered:

- History of computer systems and an introduction to machine computing.
- High-level insight into the function and connectivity of the computer.
- Cache.
- Internal memory.
- External memory.
- Input and output (I/O).
- Computer arithmetic.
- Instruction set.
- Central processing unit.
- Reduced Instruction Set Computer (RISC).
- Instruction parallelism and superscalar processors.

Course name: **SYSTEMS II – OPERATING SYSTEMS**
Number of ECTS credits: **6**

Content:
The course will cover topics that might include (but are not restricted to) any of the following according to the needs and development of the subjects covered:

- Introduction:
  what is operating system, history of operating systems, computer hardware overview, concepts of operating systems, system calls, operating system structure.
- Processes and threads:
  processes, threads, inter-process communication, critical conditions, critical region, classical IPC problems, scheduling.
- Deadlocks:
  resources, representation of processes and resources, deadlock modeling, Osterich algorithm, deadlock detection and recovery, deadlock avoidance, deadlock prevention.
- Memory:
  basic operations, swapping, virtual memory, page replacement algorithms, modeling page replacement algorithms, page management system, segmentation, Multics, Pentium.

- Input/output:
  principles of I/O hardware, principles of I/O software, software levels of I/O, disk, clock, character terminals, graphical interfaces, network terminals, other I/O equipment.
- File systems:
  files, directories, file system implementation, examples of file systems – Unix, Windows.
- Multimedia:
  multimedia files, video compression, JPEG, MPEG, scheduling multimedia processes, multimedia file systems, storing multimedia files, disk scheduling.
- Multi-processor systems:
  multi-computer systems, distributed systems, architectures and examples.
- Security:
  security environment, introduction to cryptography, user authentication, attacks from inside, attacks from outside, protection mechanisms, trusted systems.
- Unix-Linux:
  history of UNIX, overview of UNIX, UNIX processes and memory management, UNIX I/O and file system, UNIX security.

Course name: **COMPUTER PRACTICUM I**
Number of ECTS credits: **6**

Content:
- The faculty network and basic usage rules:
  Description of the faculty computer network, login methods, password changing procedure, e-mail and mailing list usage, access to e-materials.
- OS Linux basics:
  Description of the Linux OS and its many flavors, BASH shell usage basics.
- Programming language C:
  The syntax of the C programming language and its usage to solve simple problems.

Course name: **COMPUTER PRACTICUM II**
Number of ECTS credits: **6**

Content:
The course will cover topics that might include (but are not restricted to) any of the following according to the needs and development of the subjects covered:

- Advanced usage of the programming language C:
  Memory allocation and access, working with pointers.
- Advanced BASH shell commands:
  Description of the advanced commands and techniques of the BASH shell: redirections of STDIN, STDOUT and STDERR, pipelines, process management, special variables.
- Automatic text processing basics:
  Description of basic functions of text editors: Emacs, Vi, MS Word and OpenOffice Writer. Examples of use on small and larger texts. Introduction to regular expressions and examples of their use for text analysis.
- Scripting languages:
  Introduction to the languages SED, AWK, PERL and the BASH shell language. Examples of use of these scripting languages (alone and combining two or more of them together).

COMPULSORY COURSES FOR THE 2ND YEAR OF STUDY

Course name: **MATHEMATICS III - ALGEBRA II**
Number of ECTS credits: **6**

Content:
- Groups, rings, fields. Ring of polynomials.
- Vector space. Subspaces, linear operators. Linear independence. Basis and dimension of vector space.
- Eigenvalues. The characteristic and minimal polynomial.
- Inner product. Orthogonal systems. Gramm-Schmidt process of ortogonalization. Norm. Norm of the matrix and the operator. Normal and related operators.
- Convexity in the vector space.
- Normalized vector spaces as metric spaces. Isometries of R2 and R3.

Course name: **MATHEMATICS IV – COMBINATORICS WITH THE THEORY OF GRAPHS**
Number of ECTS credits: **6**

Content:
1) Mandatory topics (approximately 70%-75% of contact hours):
- Introduction. What is combinatorics? Sample problems (such as: derangements, Euler's officers, Kirkman's schoolgirls, a Ramsey game etc.).
- Basic Combinatorial Principles. The addition principle. The double counting principle. The multiplication principle. The equality principle. The pigeonhole principle (Dirichlet's principle). Generalized Pigeonhole Principle.
- Elementary Combinatorics. Ordered selections with repetition. Ordered selections without repetition (special case: permutations). Unordered selections without repetition, formula for binomial coefficients. Quotient representation of binomial coefficients. Unordered selections with repetition. Permutations with repetition. Pascal's identity and Pascal's triangle. Binomial Theorem and consequences. Principle of Inclusion-Exclusion. Counting derangements. Counting surjective functions.
- Recurrence Relations. Examples of recurrence relations. Fibonacci numbers. Linear recurrence relations with constant coefficients. Derangements, revisited.
- Distributions. Distributing labeled elements into unlabeled cells. Stirling numbers of the second kind, recurrence relation and relation to Bell numbers. Distributing labeled elements into labeled cells. Distributing unlabeled elements into unlabeled cells. Partitions of a positive integer n of order k. Distributing unlabeled elements into labeled cells.
- Graphs. Basic definitions. Graph isomorphism. Walks, trails, paths, connected components. Trees and forests: definitions and basic properties. Spanning trees. Minimum Spanning Trees: Kruskal's Algorithm. Eulerian Graphs: Euler's Theorem. Hamiltonian graphs. Hall's Theorem, systems of distinct representatives. Application: Latin squares. Graph vertex- and edge colorings. Planar graphs.

2) For the remaining 25%-30% of contact hours, the instructor shall, at his / her discretion, select topics from the following list:
2.1) Additional topics from above chapters:
- Recurrence Relations. Formal power series. Generalized Binomial Theorem. Catalan and Bell numbers.
- Graphs. Cayley's Theorem. The Traveling Salesman Problem. Digraphs. Shortest paths, Dijkstra's algorithm. Tournaments. Kőnig-Egérvary's theorem. Menger's theorem. Chromatic polynomial of a graph. Graph homomorphisms. Ramsey's theorem.
2.2) Topics from additional chapter:
- Introduction to Designs. Balanced Incomplete Block Designs - definition and examples. Steiner triple systems. Incidence matrix of a design. Fisher's inequality. Symmetric designs. Resolvable Designs. Solution to Kirkman's schoolgirl problem.
Finite projective planes, affine planes. Difference methods. Hadamard designs and Hadamard matrices.

Course name: **DATA STRUCTURES AND ALGORITHMS**
Number of ECTS credits: **6**

Content:

The basic mathematical tool
- The evaluation function O, □, □ and the differences between them
- What is the complexity of the problem and what is the complexity of solutions
- probability and randomness
- computational models: Pointer Machine, RAM, parallel computer

Basic data structures
- implicit data structures: array, stack, queue, heap
- explicit data structures: linked list, tree
- problems with concurrency

The basic abstract types and their performance
- Dictionary: hash tables, AVL, red-black, B – trees
- priority queue: heap, VEB
- ranking and selection

Sorting and friends:
- selection sort, merge sort, quicksort
- sorting in linear time
- sorting on parallel machines
- median and the k^{th} element

Basic algorithmic techniques
- greedy algorithms
- divide and conquer
- dynamic programming

Algorithms on graphs and networks
- search in width and in depth
- connected components
- minimum spanning trees
- shortest paths in graphs
- network flow
- parallel algorithms on networks with a view of the Internet

Selected algorithms
- mathematical algorithms with a view on cryptography: matrix multiplication, solving systems of equations, FFT, finding the greatest common divisor, modular arithmetic, exponents
- algorithms on strings with a view on bioinformatics: finding a substring for all problems we shall look at some basic parallel solutions

Course name: **PROGRAMMING III – CONCURRENT PROGRAMMING**
Number of ECTS credits: **6**

Content:
The course will cover topics that might include (but are not restricted to) any of the following according to the needs and development of the subjects covered:
- Concurrent programming concepts; Techniques for parallelizing programs.
- Synchronization, atomic actions.
- Critical sections: locks.
- Parallel programming: barriers, barrier synchronization, bag of tasks paradigm.
- Semaphores: basic concepts and uses, the method of passing the baton.

- Introduction to Pthreads library.
- Monitors and conditional variables: basic concepts, synchronization techniques, programming.
- Distributed memory programming: message passing, remote procedure call, remote method invocation.
- Introduction to MPI.
- Examples of multithreaded, parallel and distributed programming.
- Map-Reduce model.

Course name: **SYSTEMS III – INFORMATION SYSTEMS**
Number of ECTS credits: **6**

Content:
Modern society is based on information management, which enables it to more quickly adapt to changes in needs and requirements. Computer aided information systems play the key role in this process. This course deals with their influence on the business environment as well as with their design and development.

The course will cover topics that might include (but are not restricted to) any of the following according to the needs and development of the subjects covered:
- Basic definitions and the role of information systems in information society.
- Information systems in business process.
- Systems development life cycle (SDLC)
- Systems analysis and design, structured and object-oriented approach.
- Data and process models and diagraming techniques. Data dictionary, structure diagram, DFD, ER, ELH. Introduction to UML.
- Collecting information, traditional and modern techniques.
- Interface design, service oriented architecture (SOA).
- Cloud computing.

Course name: **INTRODUCTION TO DATABASE SYSTEMS**
Number of ECTS credits: **6**

Content:
The course will cover topics that might include (but are not restricted to) any of the following according to the needs and development of the subjects covered:
- Introduction
- Entity-Relationship model
- Relational model
- Relational algebra and calculus
- SQL and QBE
- Disks and files
- Indexes
- Evaluation of relational operations
- Query optimization
- Transactions
- Concurrency control and crash recovery
- Database design

Course name: **COMPUTER NETWORKS**
Number of ECTS credits: **6**

Content:
The course will cover topics that might include (but are not restricted to) any of the following according to the needs and development of the subjects covered:
- Basic definitions and classification of computer networks

- The reference models ISO OSI and TCP/IP.
  - The physical layer (signal transmission).
  - The data-link layer (error detection and correction, medium access, flow control).
  - The network layer (datagrams, routing, congestion control algorithms).
  - The transport layer (connection oriented and connection-less service, protocols, multiplexing).
  - The presentation layer (coding and security).
  - The application layer (sample Internet applications).
- Communication technology integration (wired, wireless and mobile), modern information services (server/client model, P2P), web services.

COMPULSORY COURSES FOR THE 3RD YEAR OF STUDY

Course name: **THEORETICAL COMPUTER SCIENCE III – INFORMATION THEORY**
Number of ECTS credits: **6**

Content:
The course will cover topics that might include (but are not restricted to) any of the following according to the needs and development of the subjects covered:

Introduction to information theory: What is information and coding

Mathematical foundations of information theory: Calculus: exponential and logarithmic functions, limits, convergence, convexity; Probability: Random variables, Inference, Expectations**,** Jensen's and Gigbbs inequality

Discrete entropy:
- Entropy,
- Joint Entropy,
- Conditional Entropy,
- Relative entropy,
- Mutual Information,
- Stochastic Process and Markov Chains,
- Asymptotic Equipartition Property Theorem (AEP)

Data Compression:
- Examples of codes
- Kraft inequality,
- Optimal Codes
- Shannon-Fano coding
- Huffman codes
- Arithmetic coding

Channel Capacity
- Examples of Channel Capacity:
- Noiseless Binary Channel, Noisy Channel with Nonoverlapping Outputs, Noisy Typewriter, Binary Symmetric Channel
- Channel Coding Theorem
- Hamming Codes
- Linear-Block Codes

Differential Entropy
- Differential Entropy
- Relation of Differential Entropy to Discrete
- Entropy
- Joint and Conditional Differential Entropy
- Relative Entropy and Mutual Information

Gaussian Channel

- Definitions
- Shannon-Nyquist sampling theorem,
- Converse to the Coding Theorem for Gaussian
- Channels, Channel capacity,
- Bandlimited Channels

Course name: **SOFTWARE ENGENEERING**
Number of ECTS credits: **6**

Content:

- Software process.
  Software development life cycle (linear model, evolutionary development, phase development, using prototypes). Phases and steps of software process.

- Languages and diagraming techniques for description of software products.
  UML (Unified modeling language). Functional model, object model, dynamic model. Use cases.

- Software requirements analysis.
  Requirements elicitation for software. Description of existing solutions. Interviews. Prototyping. Software product specification.

- Software architectural and component design.
  Software decomposition, software architecture patterns, design patterns. Software modules design and reuse.

- Software implementation.
  CASE tools. Software system integration. Software documentation.

- Software testing.
  Testing methods, black-box and white-box testing. Unit testing. Testing strategies. Debugging.

- Software maintenance and evolution.

Course name: **INFORMATION TECHNOLOGY MANAGEMENT**
Number of ECTS credits: **6**

Content:
The course will cover topics that might include (but are not restricted to) any of the following according to the needs and development of the subjects covered:

- Principles of management.
  Basic functions of management (planning, organizing, leadership, controlling).
  Management in IT environment.
  Decision Support Systems.
  Work with IT professionals.

- Information technology and organization.
  Information society concepts.
  E-business concepts.
  Virtualization of contemporary organizations and theory of virtual organizations.
  Information technologies and reengineering of organizational processes.

- Management IT services and activities.
  IT governance.
  ITIL and other standards.
  Organization of IT units.
  IT outsourcing.

- Legal regulations in EU and Slovenia.
  E-business and electronic signatures.

Data protection.
Intellectual property rights.

- Systems approach to information systems projects.
  System analysis.
  Project management.
  Information systems planning.

- Selected chapters in information engineering and case studies.
  Good practices in EU and Slovenia.

Course name: **STATISTICS**
Number of ECTS credits: **6**

Content:
- Introduction. What is statistics? Examples of applications of statistical methods in natural sciences. Population. Sample.
- Random variables. Continuous and discrete random variables. Examples of random variables. Probability function, probability density function, cumulative distribution function.
- Descriptive statistics. Frequency distribution. Measures of central tendency. Quantiles. Measures of variability.
- Sampling. Introductory examples. Random sampling. Sampling distribution. Standard error. Confidence intervals.
- Graphical methods of data representation. Histogram. Scatter plots. Box and whisker plot. QQ-diagram.
- Hypothesis testing. Null hypothesis, alternative hypothesis. Errors in hypothesis testing. Examples: t-tests (mean of single sample, means of two independent/dependent samples, ANOVA)
- Correlation and dependence. Regression. Linear regression. Measures of linear dependence. Correlation coefficients. Non-linear dependencies. Association, contingency tables.

Course name: **SEMINAR – FINAL PROJECT PAPER**
Number of ECTS credits: **6**

Content:
Presentation of the procedure for selecting the final thesis topic, the process of selecting a supervisor, and the associated constraints.
Presentation of the final thesis's structure and rules for in-text citations.
The final thesis provides a comprehensive overview of the chosen area belonging to the Computer Science study program. The student chooses a topic according to his interests and teh supervisor suggestions.
The length and structure of the thesis is defined in the instructions for writing a thesis.

ELECTIVE COURSES

(Read the short descriptions of all elective courses of the study programme. In the table Elective courses you will find the list of the elective courses which were offered in the last two years.)

Course name: **GEOGRAPHIC INFORMATION SYSTEMS**
Number of ECTS credits: **6**

Content:
- Basic terms in geographical information systems.
- Spatial data: Data structures, Data bases, Topological models.

- Maintenance of special data: Entering and processing, Interactive queries, Analyses, Presentation.
- Trends in development of geographical information systems.

Course name: **META-PROGRAMMING LANGUAGES**
Number of ECTS credits: **6**

Content:
Introduction: Judgments, inference rules, derivations, rule induction, inductive definitions, hypothetical judgment, derivability, admissibility.

Semantics of languages: Syntax, static semantics, evaluation, dynamic semantics, type safety, lambda calculus, type checking.

Meta-programming languages: Concepts of meta-programming, metaprogramming in C, C++, and Ruby, Meta-ocaml.

Logical-Frameworks: Introduction to LF, Edinburgh-LF, Twelf, Twelf programming environment, representing syntax, representation of natural numbers, simply typed LF, proving totality assertions and meta-theorems, higher-level representations.

Programming language Mini-ML: Static and dynamic semantics of Mini-ML, Mini-ML interpreter, type-checking.

Course name: **INTRODUCTION TO MACHINE LEARNING AND DATA MINING**
Number of ECTS credits: **6**

Content:
Machine learning techniques:
- From basic to more advanced machine learning methods such as: decision trees, decision rules, regression, support vector machines, association rules …
- The use of these techniques on real-life problems
- Building and evaluation of prediction and description models from the data.

Data mining:
- The use of machine learning techniques in the frame of the data mining process.
- Description of the CRISP methodology – data mining as a process consisting of the following steps: problem understanding, data understanding, data preparation, modeling, evaluation and deployment.
- The use of existing, open source data mining tools (e.g.: WEKA, Orange, A-Priori …)

Course name: **DATABASE DESIGN**
Number of ECTS credits: **6**

Content:
- Relational data model
- Data model ER
- Unified Modeling Language
- Structural design
- Conceptual database design
- Schema integration
- Translating ER schema to relations
- Case tools
- Logical database design
- Functional dependencies and normalization
- Physical database design
- Database design tuning

- Access path selection
- Denormalization of relations
- Query tuning

Course name: **LANGUAGE TECHNOLOGIES**
Number of ECTS credits: **6**

Content:
- Introduction and basics: Short history of natural language processing, inspection of the resources for natural language processing, corpora presentation
- Slovenian language corpora, monolingual corpus, bilingual corpus, corpus construction, corpora usage, presentation, labeling, network concordance
- Computer tools: Sharing of computer tools, Computer tools overview, Examples of computer tools
- Machine Translation: techniques of machine translation techniques, evaluation of machine translation, statistical machine translation
- Modern methods of collecting relevant linguistic information from computer manageable corpora

Course name: **MULTIMEDIA DESIGN**
Number of ECTS credits: **6**

Content:
Nowadays, multimedia is widely used to transfer information between users – especially those that are not »computer experts«. The state-ot-the-art communication technology enables the integration of different media such as: text, graphics, high-resolution images, sound and video.

Content:
- Multimedia systems – basic concepts.
- Digitalization of information.
- Use of multimedia systems.
- Development of multimedia systems.
- The use of multimedia systems to produce multimedia content.
- The use of multimedia systems and multimedia content in other systems.

Course name: **INTRUDUCTION TO BIOINFORMATICS**
Number of ECTS credits: **6**

Content:
- Introduction
- Basic biological background, comparison of samples
- A comparison of two strings: algorithms for exact match
- A comparison of two strings: heuristics
- Finding patterns and the best match.
- Suffixal tree
- A comparison of multiple sequences
- Creation of evolutionary trees

Course name: **COMPILERS**
Number of ECTS credits: **6**

Content:

Introduction:
- Basic structure of the compiler. Regular languages and context-free grammars and parsers-
- Basics of regular languages and context free languages-
- Lexical analysis and parsing-

Block structure, scope and symbol tables:
- Importance of the block structure.
- Enviroment and variables in environment.

The semantics:
- Semantic analysis, types, variables.
- Overloading, basics of polymorphism.

Memory organization:
- Stack during the program execution.
- Calling records and subroutine call and return from it.
- Parameter passing by value and by reference.
- Heap organization (free memory).

Code generation:
- Intermediate code, and its forms.
- Basics of code generation analysis.
- Code generation for parallel languages.

Code optimization:
- Overview of basic methods.

Course name: **SYSTEM PROGRAMMING**
Number of ECTS credits: **6**

Content:
- Unix:
  Users. Authentication. User administration. Groups. Files and permissions. User groups. Devices. Processes. Ports. Network file systems – NFS. Samba. Security. OS boot sequence. Services. Firewalls.
- System programming languages:
  Unix shell & programming. Perl & programming. Example of a system program.
- Windows:
  Users, groups and layers. Authentication. Active directory. Processes. Domein server. Application server. Security. Open SSL. VPNs. Archiving.

Course name: **ICT IN EDUCATION**
Number of ECTS credits: **6**

Content:
- Historical and technological development of ICT support in educational processes
- Technological aspects of ICT supported education
- Institutional framework for ICT supported education
- Quality of electronic learning content and its publishing in electronic media
- Systemic organization of social and cultural enviroment in the field of ICT supported education.
- The political importance of lifelong learning (LLL)

Course name: **CODING THEORY**
Number of ECTS credits: **6**

Content:
- Mathematical background (groups, rings, ideals, vector spaces, finite fields);
- Basic concepts in coding theory;
- Algebraic methods for the construction of error correcting codes;
- Hamming codes;
- Linear codes;
- Binary Golay codes;
- Cyclic codes;

- BCH codes;
- Reed-Solomon codes;
- Bounds (Hamming, Singleton, Johnson's bound ...)

Course name: **SELECTED TOPICS IN PROGRAMMING LANGUAGES**
Number of ECTS credits: **6**

Content:
- Overview of programming languages
- Functional programming languages
- Logic programming languges
- Paralell programming languages
- Introduction to compilers and interpreters
- Programming technologies for massively parallel systems
- New trends in programming languages

Course name: **AUGMENTED REALITY**
Number of ECTS credits: **6**

Content:
- Review of Augmented Reality (AR) concepts tools and usecases (for the web, desktop, handheld and head mounted displays).
- Methods of representing the real world (e.g. understanding the peephole camera model, the video and optical seethrough display, the head mounted display).
- Looking at the building blocks for superimposing the world (e.g. introduction to OpenGL, matching real-camera or optical see through display with the virtual camera);
- Overview of absolute and relative camera pose registration methods utilizing sensor (i.e. compass, gyroscope, accelerometers) and vision (RGB camera, RGB-D camera) based approaches ;
- Calibration of Optical See-through and head mounted displays.
- Designing AR interfaces and experiences.

Course name: **HUMAN – COMPUTER INTERACTION**
Number of ECTS credits: **6**

Content:
- Review of the research area as an intermediate link between ingeneering and designing
- A detailed overeview of individual steps in user-centered design: understanding the problem, requirements analysis, prototyping, evaluation.
- Review of human perception, cognitive processes, human actions, feelings and experiences.
- Use of prototyping techniques.
- Use of quantitative and qualitative techniques for evaluating the system / product on different stages of development.
- Review of other important topics such as mental models, direct manipulation, grids and alignments, typography, navigation, distributed cognition.

Course name: **LEARNING, GAMES AND GAMIFICATION**
Number of ECTS credits: **6**

Content:
- Review of the historical development of games and gamification, fields of application, elements of the game and thinking processes.
- A detailed overview of psychological processes, motivation, cognition, perception and attention.
- Knowledge of design techniques and programming content, frameworks, and culture of gameplaying.
- Use of games and gamification in various levels of teaching/learning from educational to corporative environments.

- Review of other important topics such as criticism, threats, legal frameworks, etc.

Course name: **GAME DEVELOPMENT**
Number of ECTS credits: **6**

Content:
- A detailed overview of individual steps of 3D game development: understanding the problem, requirements analysis, prototyping, evaluation.
- Use of prototyping techniques.
- Unreal SDK: IDE tool for 3D game development.
- The architecture of a modern 3D toolkit/framework.
- Quaternions through examples.
- Robust messaging system implementation.

Course name: **DECISION SUPPORT SYSTEMS**
Number of ECTS credits: **6**

Content:
- Decision theory;
- Multi-criteria decision making;
- Voting systems, Arrow's paradox;
- Decision trees;
- Decision support systems (HiView, DEXi, GeNIe Modeller etc.);
- Building expert systems;
- Use of data mining techniques for decision making;
- Costs and benefits analysis;
- Recommender systems: collaborative filtering; slope one; content-based filtering; evaluation of recommender systems;

Course name: **ADAPTIVE INTERACTIVE SYSTEMS**
Number of ECTS credits: **6**

Content:
The course will cover topics that might include (but are not restricted to) any of the following according to the needs and development of the subjects covered:
- Adaptive Hypermedia
- User Modelling
- Content-based and collaborative filtering
- Group modelling
- Affective and persuasive computing
- Context modeling
- Explainability, trust, fairness, privacy
- Novelty, Diversity and Serendipity
- Application domains
- Evaluation of adaptive systems

Course name: **DIGITAL SIGNAL PROCESSING AND ANALYSIS**
Number of ECTS credits: **6**

Content:
Signals and systems:
Analog and digital signals, sampling theorem, delta function, quantization, linearity, superposition, decomposition, noise.

Signal processing fundamentals:

Convolution, correlation, (discrete) Fourier transform, complex and polar signal notation, Laplace transform, Z-transform, Hilbert transform, Wavelet transform.

Digital filtering:
time domain and frequency domain parameters, filter classification, moving average filters, FIR filters, IIR filters.

Signal analysis domains:
Time domain, Frequency domain, Time-frequency domain.

Signal analysis methods:
statistics in different domains, correlation, spectral analysis, signal interdependence, autoregressive systems.

SKILLS MODULES

Course name: **LDAP SERVER, CONFIGURING**
Number of ECTS credits: **4**

Content:
- Configuring a domain server for directory use
- Configuring the directory infrastructure
- Configuring additional roles
- Creating and maintaining objects in the directory
- Object management in the directory
- Configuring certification services for directory use

Course name: **APPLICATION DEVELOPMENT FOUNDATION**
Number of ECTS credits: **2**

Content:
- Implementation of system types and interfaces
- Implementation of collections and generics
- Configuration and installation of products
- Controlling and debugging applications
- Reading and writing to files
- Serialization
- Implementation of delegates and events
- Support to internationalization, globalization and localization
- Implementation of cryptography and computer security
- Connecting COM components
- Working with types
- Making of a multithread application

Course name: **LINUX ESSENTIALS**
Number of ECTS credits: **2**

Content:
- Understanding Linux file system
- System maintenance basics
- Usage and configuration of the desktop environment
- Working with the command-line

- Working with the desktop environment
- Usage of the text editor
- Rights and privileges
- Using command-line and the desktop environment
- Tools and commands for printing
- Configuring the window server
- Regular expressions and redirections
- Copying from an to removable media
- Usage of the package manager
- Basic network tools for the user
- Tools for the system administrator

Course name: **WORKING AT A SMALL-TO-MEDIUM BUSINESS OR ISP**
Number of ECTS credits: **4**

Content:
- Internet, usage and network service providers
- OSI model and error handling at the network provider side
- Network upgrade planning and address structure planning
- Network device administration and routing
- Network provider services and responsibilities
- Handling network errors

Course name: **LINUX SYSTEM ADMINISTRATION**
Number of ECTS credits: **2**

Content:
- Linux installation with standard/non-standard hardware
- Creation and modification of the Linux file system
- System administration – user and group level
- Controlling standard hardware
- Integration of a workstation into a network environment
- Installation of NIS and DHCP clients
- Installation of NFS and SMB clients
- Installation of inetd network server
- Installation of the X server and desktop environments
- Controlling the system
- Basic problem solving
- System security enforcement

Course name: **DESIGNING A DATABASE SERVER INFRASTRUCTURE BY USING SQL SERVER**
Number of ECTS credits: **2**

Content:
- Infrastructure planning
- Server security planning
- Database system planning
- Planning for high data availability solutions
- Planning scenarios for data loss recovery
- Planning for database archiving

Course name: **LINUX NETWORKING ADMINISTRATION**
Number of ECTS credits: **2**

Content:
- OS Linux basics

- Installation of various server-side software that enables the user to use different services (HTTP, DNS, SMTP, SMB, DHCP, FTP, PPP and others)
- Getting to know different network protocols (FTP, HTTP, SMTP ...)

Course name: **SERVER ADMINISTRATION**
Number of ECTS credits: **2**

Content:
- Planning the server system
- Planning the maintenance
- Controlling and maintenance of services
- Planning the needs for hardware and data
- Planning for high availability of the server and services

Course name: **LINUX SECURITY ADMINISTRATION**
Number of ECTS credits: **2**

Content:
- Security policy planning
- Local security
- File system security
- Passwords
- Cryptography
- Kernel security
- Firewall basics
- Security tools – overview
- Handling attack attempts
- Security methods and measures

Course name: **INTRODUCING ROUTING AND SWITCHING IN THE ENTERPRISE**
Number of ECTS credits: **4**

Content:
- Businesses and their needs for network services depending on their size and growth rate
- Assessing the current state of the network
- Switching and VLAN networks, addressing and routing
- Establishing WAN connections
- Filtering network traffic by using ACLs
- Error handling in enterprise networks

Course name: **NETWORK INFRASTRUCTURE, CONFIGURING**
Number of ECTS credits: **4**

Content:
- Configuring internet access
- Configuring network services
- Configuring the domain service
- Configuring file and print servers
- Controlling and management of network infrastructure

Course name: **DESIGNING DATABASE SOLUTIONS BY USING SQL SERVER**
Number of ECTS credits: **2**

Content:
- Planning the database

- Planning of the objects
- Planning products for the SQL server
- Planning products that use the SQL server
- Planning procedures for testing and maintenance of code

Course name: **CORE WINDOWS CLIENT DEVELOPMENT**
Number of ECTS credits: **2**

Content:
- User forms implementation
- Controls configuration and implementation
- Making the menus
- Data access basics
- Reading and writing to files
- Printing and report making
- Implementation and installation of network services
- Support to internationalization, globalization and localization
- Making a web application.

Course name: **OPTIMIZING AND MAINTAINING A DATABASE ADMINISTRATION SOLUTION BY USING SQL SERVER**
Number of ECTS credits: **2**

Content:
- Server and database operation optimization
- Optimization and database restore in case of data loss or error
- Database server control strategy planning
- Data management strategy planning
- Security management strategy planning

Course name: **NETWORKING FOR HOME AND SMALL BUSINESSES**
Number of ECTS credits: **4**

Content:
- PC, hardware and operating system
- Structure of a computer network, connecting to the network, internet providers
- Network addressing and services
- Wireless networks and security
- Basic concept of computer security
- Managing errors in the network

Course name: **SQL SERVER – IMPLEMENTATION AND MAINTENANCE**
Number of ECTS credits: **4**

Content:
- Installation and configuration of the SQL server
- Maintenance of high accessibility of data and data loss management
- Data querying support
- Maintenance of the SQL server
- Control and suppression of system interruption or breakdown
- Building SQL objects

Course name: **DESIGNING AND SUPPORTING COMPUTER NETWORKS**
Number of ECTS credits: **4**

Content:

- Concepts of network design
- Ways of collecting network service requests and evaluation of the current state
- Evaluation of software in use and its impact to the network traffic (in the planned computer network)
- Devising a plan of a new computer network
- 2 prototypes of computer networks: student campus network, wide area network
- Upgrading an existing computer network

Course name: **DESIGNING AND OPTIMISING DATA ACCESS BY USING SQL SERVER**
Number of ECTS credits: **2**

Content:

- Planning for effective access to SQL server services
- Planning query strategies
- Planning error-handling routines
- Planning transaction strategies
- Synchronization of database services with products