Transilvania University of Brasov, Romania

Study program: Computer Science

Faculty: Mathematics and Computer Science
Study period: 3 years (bachelor)
1st Year

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Mathematical Analysis	AP01	5	3	2	0	0

Course description (Syllabus): Relations (properties of a relation, equivalence relations, order relations, function as an example of a relation); Using axiomatic properties of the set of real number; Sequences and series (sequences and series of real numbers, sequences and series of functions); Determining the radius of convergence and interval of convergence of power series; Using the Taylor series expansions of function; First order and higher order partial derivatives of real-valued functions of several variables, the Schwarz theorem, the first order differential and the partial derivatives of a composite real function; Study extremes of the real differentiable functions of several variable; Constrained extrema, the method of Lagrange multiplier; Establish the nature and calculation of improper integrals; Calculation of integrals depending on a parameter; Calculation of line integral; Calculation of multiple integrals.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Basic algebra for computer science	AG13	5	2	2	0	0

Course description (Syllabus): Functions and relations, Binary operations, Free semigroups, Groups, Permutations, Rings and fields, Tropical geometry, Matrices, Vector spaces, Linear codes.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Fundamental Algorithms	IT11	6	2	1	2	0

Course description (Syllabus): This course introduces fundamental concepts in algorithms, covering the building blocks of algorithm design. Topics include pseudocode, variable and constant usage, instructions, and visibility of variables (global/local) within an algorithm. The curriculum explores subprograms, recursion, and the analysis of algorithm efficiency, including computing complexity across various scenarios. Specific algorithmic categories such as search and sort algorithms, divide and conquer algorithms, greedy algorithms, dynamic programming algorithms, and text processing algorithms are discussed. The course also involves a comparative analysis of implementations and programming methods. Additionally, it delves into intelligent algorithms, providing a foundational understanding of artificial intelligence concepts through research and case studies on selected issues. Practical components include problem-solving seminars on fundamental algorithm topics and hands-on laboratory sessions for the implementation of discussed algorithms.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Programming Fundamentals	IF11	5	2	0	2	0

Course description (Syllabus): Getting familiar with the C language; Generic programming using macros; Understanding procedural programming; Pointers. Memory allocation and management; Developing function-oriented C applications.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Mathematical and Computational Logic	IT13	5	2	1	0	0

Course description (Syllabus): Binary, decimal, octal, hexadecimal number systems; Conversions among bases; Addition, subtraction, multiplication and division of base b numbers, Representation of integer numbers (Sign and magnitude, One's complement, Two's complement); Addition, subtraction and multiplication of two's complement numbers; Fixed point numbers; Floating Point Numbers. The IEEE 754 Floating Point Standard (Formats and Rounding), Properties of Boolean Algebra; Truth Table; Boolean Functions. The disjunctive normal form and conjunctive normal form; Minimization of Boolean functions: Veitch-Karnaugh Maps, Quine McCluskey's method; Combinatorial circuits; The Algebra of GF(2). The operational and function domains; Reed-Müller expansions; Generalized Reed-Müller expansions.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Academic Writing	RCS01	2	1	0	2	0

Course description (Syllabus): LaTeX – Overview, Logical Organization of a Document in LaTeX, Writing text and mathematical formulas, Graphing and writing algorithms, LaTeX packages and their use in writing, Using colors and graphics processing, Beamer document class, Writing a scientific paper in LaTeX.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
English Language (1)	LE1	2	1	1	0	0
German Language (1)	LG1					

Course description (Syllabus): The English/German language course attempts at revising, consolidating and improving grammar points at advanced level. It also provides opportunities for students to practice grammar structures and express themselves during the seminars. To this end, each lecture presents a theoretical issue which synthesizes essential information from outstanding books in English/German morphology, followed by a wide range of exercises which will be approached during the following seminar. The exercises are designed in such a way so that students can solve them both individually and in pairs, during the seminars. The aim of this course is to provide students with comprehensive grammar structures linked to the following issues: problem verbs, modal verbs, passive voice, determiners and pronouns and relative clauses.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Linear Algebra, Analytical and Differential Geometry	AG03	5	2	2	0	0

Course description (Syllabus): Basic notions of linear algebra (vectors, calculus with vectors, dependence and independence linearity, bases, dimensions, linear applications, bilinear forms, and quadratic forms, scalar products and other products); Matrix representation from linear algebra (of vectors, linear applications, bilinear forms and quadratic forms, of vectors products); Basic notions of analytical geometry (point, line, conic, plane, quadric and its equations, frame, relative positions, angles, distances); To apply techniques from linear algebra in analytical geometry, the knowledge of basic elements from differential geometry of curves and surfaces; Explain the necessity for use specific techniques of linear algebra and analytical geometry in mathematics, physics, technique and informatics; Explain the use of specific techniques of linear algebra and analytical geometry (in particular and in details); Matrix interpreting the abstract definitions from linear algebra; Mathematics significations interpreting of some calculated elements; Use theoretical knowledge for problem solving; Interpreting algebraic and geometric some notions related to informatics.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Computer Systems Architecture	IT21	5	2	1	1	0

Course description(Syllabus): The Computer Architecture content attempts at using theoretical computer science fundamentals for describing the modern computers' structure and organization, in order to efficient value the hardware characteristics in the software programming solutions; introducing the main concepts in computer architecture; understanding the basic concepts in modern computer architecture; identifying and distinguishing between the hardware and software components of a given computer system; understanding the inner-workings of modern computer systems, their evolution and the present aspects about the hardware-software interface; enabling students to design and recognize the structure of a basic computer system, including the design of the I/O subsystem, the memory system and the processor data path and control; presenting how a personal computer system operates. Appropriate working with the specific concepts of the computer architecture are focused and specific set of basic assembly language programs for the specific model of processor in use are developed.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Object Oriented Programming	IT22	6	2	0	2	0

Course description (Syllabus): Getting familiar with the C++ language; Understanding OOP concepts; Developing OOP applications in C++.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Data Structures	IT23	6	2	0	2	0

Course description (Syllabus): Data structures used for efficiently storing and manipulating data in computer programs: linear structures like stacks, queues, linked lists; hash tables; binary search trees, balanced trees, heaps; advanced data structures: quadtrees, point-region trees, kd-trees, persistent trees. The data structures are described in the context of their applicability, together with the main operations and their complexity. Description of some data structures from the STL C++ library. In the laboratory: implementation of the data structures, using the data structures for solving problems.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Operating Systems	IF21	6	2	0	2	0

Course description (Syllabus): Assimilating the basic concepts of operating systems; Knowledge of theoretical concepts of operating systems Windows and Linux; Knowledge of interface elements of operating systems; Developing the skills to use resources provided by operating systems in applications development; To use MSDOS, Windows and Linux Interfaces; To write command files / scripts under MSDOS / Linux; To develop applications in C that use the resources offered by operating systems; To use specific algorithms of operating system.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
English Language (2)	LE2	2	1	1	0	0
German Language (2)	LG2					

Course description (Syllabus): The main objective of English/German language seminars from the second semester is that of consolidating and improving the English/German language knowledge acquired by students up to that point. This time the focus is no longer grammar but students' ability to express themselves as fluently and as accurately as possible by means of using a wide range of vocabulary items. To this end special material providing them with texts and exercises covering various artistic, cultural, political and social issues will be used. Apart from the emphasis placed on developing students speaking skills, the seminars will also focus on students' ability to communicate in writing. They will be taught to develop and organize their ideas logically and coherently, while at the same time using the language correctly.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Physical Education and Sport 1	EF01	2	0	2	0	0

Course description (Syllabus): Education / develop basic motor skills and specific of branches / sports events; Formation of a system of motion skills and general (basic and specific application or utility samples / sports branches); Appropriation of means and structures for learning exercises, strengthening, and improving the technical elements specific sports games.

2nd Year

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Graph algorithms	IT31	5	2	0	2	0

Course description (Syllabus): The students learn about graph theory;Algorithms for classical graph theory problems are studied (e.g. graph search, shortest path, minimum spanning tree, maximum flow, minimum cost flow); Practical problems are solved using algorithms for graphs.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Formal languages and automata theory	IT32	5	2	1	1	0

Course description (Syllabus): Automata theory stands at the core of theoretical computer science, encompassing crucial concepts essential for various applications. This course explores the theoretical formalization and automata, providing insights into their role in programming language compilation, text editor construction, and network modeling. Participants will develop skills in working with formal elements intrinsic to theoretical computer science. Key concepts covered include Markov systems, grammars, Chomsky classification, automata, push-down automata, regular expressions, and various types of analysis within the compilation flow.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Programming environments and tools	IF31	5	2	0	2	0

Course description (Syllabus): This course begins with introductory elements, exploring the fundamental question of why object-oriented programming is significant. It explores the key concepts and principles of object-oriented programming, focusing on specifying and implementing a class with a Java perspective. The course covers inheritance and polymorphism in object-oriented programming, providing insights from the Java standpoint. Additionally, the module addresses structured exception handling in object-oriented programming, the intersection of object orientation and generic programming in a Java context, and explores object-oriented flows and object serialization, offering a comprehensive understanding of these essential aspects.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Databases	IT33	5	2	0	2	0

Course description (Syllabus): Differences between logical and physical views of data, Data Modelling, Logical Database Design, ANSI/X3 / SPARC model, Entity Relationship Model, Design Rules for Data Modelling, Main steps in the logical program design, Modes of operation and their symbolic presentation, Case Study: Manage Owners Association, SQL commands, Database implementation Examples: Library management, restaurant management, employee management, management of a medical cabinet, management of a CD collection, resource management of a computer network, etc.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Artificial intelligence	IF42	5	2	0	2	0

Course description (Syllabus): Creating data-driven models; Introducing heuristic models for solving specific classes of problems; Building classifiers and regression models; Machine learning models based on artificial neural networks; Genetic algorithms for optimization; Uncertainty management based on fuzzy logic and fuzzy sets.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Automata, calculability and complexity	IF	5	2	1	1	0

Course description (Syllabus): Defining the basic concepts and principles of computer science, as well as mathematical theories and models; Interpretation of mathematical and computer models; Identifying appropriate models and methods for solving real-world problems.; The use of simulation to study the behavior of the models also achieves performance evaluation.

Incorporating formal models into specific applications in various domains; Adequate description of programming paradigms and specific language mechanisms, as well as identifying the difference between semantic and syntactic order aspects; Develop appropriate source code and unit test components in a known programming language based on given design specifications; Testing applications based on test plans; The development of program units and the elaboration of related documents.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Advanced methods of programming	IF	5	2	0	2	0

Course description (Syllabus):.NET framework architecture; Object oriented programming in C#; Collections and generic data types; Developing applications with database systems; Using LINQ to objects; Working with threads and streams.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Computer networks	IF44	5	2	0	2	0

Course description (Syllabus): Assimilating the basic concepts on which the computer networks; Learning some basic notions on current network technologies; Acquisition of necessary knowledge for distributed programming; Formation of required skills for computers network administration; Using Windows commands to manage computer networks; IP and MAC addresses; Using and programming various algorithms for computer networks; To establish a local network and an inter-network.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Numerical calculation	IF	5	2	0	2	0

Course description (Syllabus): Numerical methods for solving equations, systems of equations, numerical methods for calculation of derivatives, integrals, etc.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Modern C++ applied in artificial intelligence	IT34	5	2	0	2	0

Course description (Syllabus): This course is centered around tracing the evolution of the C++ language. By mastering the introduced concepts, participants will gain the ability to craft modern C++ code characterized by improved safety, speed, and simplicity. The C++ standard has undergone a continuous evolution with the introduction of C++11, C++14, C++17, and C++20. These updates facilitate writing more concise code, eliminating memory leaks, and enhancing overall runtime performance. Additionally, certain modules of the course focus on providing a C++ perspective for

implementing practical, project-oriented artificial intelligence components in hands-on labs.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Modern 3D graphics modeling systems in C++ with OpenGL and DirectX	AG131	5	2	0	2	0

Course description (Syllabus): The course deals with the study of the programming concepts needed to create 3D graphics applications. The main objectives are: Building a graphic model of a scene with 3D objects, Implementing and using 3D graphics algorithms, Performing the graphic transformations necessary to visualize a scene with 3D objects on the screen, Performing virtual reality special effects, Building interactive graphics applications in C++ using libraries Vulkan/OpenGL and DirectX graphics libraries.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Build a real-time Web app using Angular, Net Core and SignalR	IF	5	2	0	2	0

Course description (Syllabus): FrontEnd: HTML, SCSS, Typescript, Components & Modules, Routing, Services, Http & SignalR; BackEnd: Net Core, Controllers, WebSockets, Services, MongoDB.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	Project
Physical Education and Sport 2	AG141	2	0	2	0	0

Course description (Syllabus): Education / develop basic motor skills and specific of branches / sports events; Formation of a system of motion skills and general (basic and specific application or utility samples / sports branches); Appropriation of means and structures for learning exercises, strengthening, and improving the technical elements specific sports games.

3rd Year

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Software engineering	IF51	5	2	0	2	0

Course description (Syllabus): Knowledge and application of software development concepts, principles and techniques Training and development of skills in the use of software engineering support techniques; Acquiring specific knowledge of Scrum, Kanban, Extreme Programming, etc.; Understanding how to apply Agile practices.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Human-computer interfaces	IF52	5	2	0	2	0

Course description (Syllabus): appropriating the modern Internet of Things context for the development of a team project, based on an IoT approach of integrating specific hardware and software components for a suitable practical context mastering the specific elements of description and characterization of the IoT field; designing and assembling a hardware prototype and implementing an associated application to develop a team project with IoT architecture in a useful practical context; the recognition of the specific IoT issue, for the reasoned support of a personal point of view on current topics in the context.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Development of web applications	IF52	5	2	0	2	0

Course description (Syllabus): Description of the structure of a website and the operation of a modern computer system, in order to effectively use computer resources in the current activity of the future computer scientist; Processing of the raw materials of the site: the texts, graphics, animations and sounds embedded in the prototype of the site; Online testing of the application; Integrating technologies, databases and e-commerce systems into the created prototypes; Ensuring product maintenance by updating information, monitoring the site and completing or modifying its structure.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
IT project management	IF45	5	2	1	1	0

Course description (Syllabus): the presentation of fundamental concepts, technologies and best practices in the modern management of IT projects in order to effectively manage software application development projects; developing the students' ability to organize, estimate and monitor the evolution of a software development project; developing students' ability to work in software development teams.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Parallel, concurrent and distributed programming	IF	5	2	1	1	0

Course description (Syllabus): Acquiring parallel programming in MPI and GPU; Knowledge of the main components of programming languages for distributed architectures and GPUs:MPI Programming for Distributed Systems; CUDA programming for GPU systems; Fundamental parallel algorithms.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Probability and statistics	IF45	5	2	1	1	0

Course description (Syllabus): Fundamental knowledge of probabilities and mathematical statistics and their use in problem solving. Among the important elements of the content: Field of events, operations with events. Probability field: classical/axiomatic definition, Conditional probability. Independent events. Total probability formula, Bayes' formula. Probabilistic schemes (two-state hypergeometric scheme, multi-state hypergeometric scheme, Poisson scheme, binomial scheme, multinomial scheme, Pascal's scheme) Random variables and discrete probability laws. The distribution function associated with a discrete random variable.

Course title	Code	No. of credits	Number of hours per week			
			course	Seminar	laboratory	project
Practice	IT53	5	0	0	0	8

Course description (Syllabus): Improvement of the didactic activities and the students' vocational training by placing students in real situations of software development and by practicing the basic competences regarding human relations within working conditions; Placing students in real situations of software development; Qualified company personal attendance to student's practical training; Practicing the competences regarding human relations within working conditions; Increasing students' motivation regarding their theoretical and practical preparation by offering them a better knowledge about their future profession; Preparing young graduates for the work market, by acquiring practical experience during the period of university studies; Supervising and validation of the students activity both by the university mentor and the person appointed by the company; Providing detailed and reliable information regarding the future students profession.

Course title	Code	No. of credits	Number of hours per week			
			course	Seminar	laboratory	project
Practical Coordination for Bachelor Thesis	IF63	5	0	0	0	6

Course description (Syllabus): Improvement of the didactic activities and the students' vocational training by placing

students in real situations of software development and by practicing the basic competences regarding human relations within working conditions; Placing students in real situations of software development; Qualified company personal attendance to student's practical training; Practicing the competences regarding human relations within working conditions; Increasing students' motivation regarding their theoretical and practical preparation by offering them a better knowledge about their future profession; Preparing young graduates for the work market, by acquiring practical experience during the period of university studies; Supervising and validation of the students activity both by the university mentor and the person appointed by the company; Providing detailed and reliable information regarding the future students profession.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Digital image processing	IF45	5	2	0	2	0

Course description (Syllabus): Understanding some basic data elements of digital image processing and adapting them to real problems; Developing students' ability to approach image processing problems, to implement basic algorithms; Developing students' ability to interpret and evaluate the results produced by their own programs, to adapt general methods to given problems.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Human-computer interaction	IF	5	2	0	2	0

Course description (Syllabus): The key components of HCI: the user, the machine – the objects – the context – the context-dependent tasks, the interface; Characteristics of an HCI system: utility, efficiency and comfort, safety and security, accessibility, adaptability; Examples of systems with a high level of human-computer interaction: Automated Teller Machines, vending machines, traffic control systems, time-critical systems, self-driving systems, smart wearable systems, assistants and sensory agents, health monitoring oriented systems, guidance and direction systems, systems for people with disabilities, interactive educational systems, pre-touch sensing, paper ID; Related technologies and concepts: Human-oriented, human-centered IoT, Augmented-Reality, Virtual-Reality, Mixed-Reality, NLP (Natural Language Processing.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Designing mobile applications	IF46	5	2	0	2	0

Course description (Syllabus): Learning the main components of a programming language for mobile applications and their application in the design and development of a project; Knowing the main components of a programming language for mobile devices; Components for UI Interfaces; Work with local and web databases; Graphics and animation; Mobile application design methods.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Developing computergames in Unity with C#	IF	5	2	0	2	0

Course description (Syllabus): The aim of the course is the study of programming concepts, which are the basis3D computer games; Students will acquire the following theoretical and practical skills aftergoing through the didactic activities: They will deepen the fundamental notions necessary for the development of a 3D engine inC# for games, platform independent (desktop or mobile), e.g.: Scripting, textures, Prefabs, Layers, Physics, Constraints. Meshes; Students will develop a 3D object rendering engine using Unity in C#, which will be able to run platform independent; Students will understand how the camera works and user interaction using the keyboard and mouse; Students will write vertex and fragment shaders that they will run directly on graphics card.