

İZMİR INSTITUTE OF TECHNOLOGY
FACULTY OF ENGINEERING
DEPARTMENT OF COMPUTER ENGINEERING
UNDERGRADUATE PROGRAM

ENG 101 Development of Reading and Writing Skills I (3+0)3 3 Ects

ENG-101 covers academic reading and writing skills, technical writing, paraphrasing and summarizing techniques, problem-solution writing, and oral presentation skills. The course also introduces APA citation, academic integrity, and note-taking strategies. Students will engage in various tasks, including formal email writing, structured academic discussions, and presentations.

ENG 102 Development of Reading and Writing Skills II (3+0)3 3 Ects

This is a course which aims to equip students with the skills to analyze essays and articles, to write an organized essay and article, to make presentations, to take notes while listening and reading skills, which will help them in their academic studies.

OHS101 Occupational Health and Safety I (1+0)1 Ects 1

This course introduces the fundamental concepts of occupational health and safety in engineering, design, and laboratory practices. It covers occupational accidents, occupational diseases, risk assessment methods, and relevant legal regulations. It also aims to develop students' awareness of safety culture and preventive approaches in workplaces.

OHS102 Occupational Health and Safety II (1+0)1 Ects 1

This course covers physical, chemical, biological, and ergonomic risk factors in industrial environments, along with the control measures for these risks. It also includes emergency management and workplace safety practices.

ECON 205 Principles of Economics (3+0)3 4 Ects

This course introduces students to economics, basic concepts, and provides general information on microeconomics, macroeconomics, fiscal policy, and monetary policy.

Course Learning Outcomes:

1. To gain general knowledge about the basic concepts of economics.
2. To develop the ability to follow, evaluate, and understand current economic events throughout life, and to acquire an innovative perspective.
3. To gain knowledge of the fundamental concepts of microeconomics.
4. To acquire general knowledge about macroeconomics, monetary policy, and fiscal policy.

TURK 201 Turkish Language I (2+0)0 2 Ects

Definition of language, the place and importance of language as a social institution in the life of a nation, the position of Turkish among world languages, word exchange between languages, vocabulary, basic phonetic and lexical characteristics, and the evaluation of the current situation of Turkish.

TURK 202 Turkish Language II (2+0)0 2 Ects

Turkish writing expression, identification, discussion and practical training for oral and written expression

TURK 203 Turkish for Foreigners (2+0)0 2 Ects

Turkish sound knowledge of basic level, simple sentence structures, establish a dialogue, introducing yourself

TURK 204 Turkish for Foreigners (2+0)0 2 Ects

The foundation of Turkish Republic, Principles of Atatürk and major events and changes that have taken place in politic, society, economy, and culture as a results of revolution for reorganization of state and society.

HIST 201 Principles of Ataturk I (2+0)0 2 Ects

The modernization of the Ottoman Empire during the nineteenth and early twentieth centuries, the spread of nationalism, and the revolutionary changes in Ottoman institutions and society that led to the Empire's demise, the transitional period from the Empire to the national state and the foundation of the Turkish Republic following the national struggle led by Mustafa Kemal Atatürk.

HIST 202 Principles of Ataturk II (2+0)0 2 Ects

The foundation of Turkish Republic, Principles of Atatürk and major events and changes that have taken place in politic, society, economy, and culture as a results of revolution for reorganization of state and society

HIST 203 History of the Turkish Revolution I (2+0)0 2 Ects

The modernization of the Ottoman Empire during the nineteenth and early twentieth centuries, the spread of nationalism, and the revolutionary changes in Ottoman institutions and society that led to the Empire's demise, the transitional period from the Empire to the national state and the foundation of the Turkish Republic following the national struggle led by Mustafa Kemal Atatürk.

HIST 204 History of the Turkish Revolution II (2+0)0 2 Ects

The foundation of Turkish Republic, Principles of Atatürk and major events and changes that have taken place in politic, society, economy, and culture as a results of revolution for reorganization of state and society.

MATH 255 Differential Equations (4+0)4 6 Ects

First-order equations and various applications. Higher order linear differential equations. Power series solutions: ordinary and regular singular points. The Laplace transform solution of initial value problems. Systems of linear differential equations: solutions by operator method, by Laplace transform.

PHYS 101 General Physics I (4-0)4 – ECTS: 5

Scientific notation, concepts of length, time, and mass, unit systems, and dimensional analysis. Linear motion. Motion in two and three dimensions. Force and motion: Newton's laws and their applications. Kinetic energy, work, power, and potential energy. Linear momentum and its conservation, collisions. Rotational motion, angular momentum and its conservation. Equilibrium and elasticity. Gravitational force.

PHYS 111 General Physics Lab. I (0+2)1 – 2 Ects

Experiments covering the topics of PHYS 101 General Physics I will be performed by students in the laboratory course.

PHYS 102 General Physics II (4-0)4 – 5 Ects

Electric charge, Coulomb's law, electric field and field lines. Gauss's law. Electric potential and electric potential energy. Capacitance and dielectrics. Electric current. Direct current circuits. Effects of magnetic fields. Properties and generation of magnetic fields: Ampère's law, Gauss's law, and Biot–Savart law. Faraday's law of induction. Magnetism and magnetic properties of matter.

PHYS 112 General Physics Lab. II (0+2)1 – 2 Ects

Experiments covering the topics of PHYS 102 General Physics II will be performed by students in the laboratory course.

MATH 141 Calculus I (3+2)4 5 Ects

Functions and Their Graphs, Limits and Limit Rules, Continuity, Derivatives, Applications of Derivatives, The Intermediate Value Theorem, The Mean Value Theorem, Concavity and Curve Sketching, L'Hospital's Rule, The Definite Integral, Fundamental Theorem of Calculus, Indefinite Integrals and the Substitution Method, Area Between Curves.

MATH 142 Calculus II (3+2)4 6 Ects

Application of Integrals, Techniques of Integration and Improper Integrals, Sequences and Series, Partial Derivatives, An Introduction to Double Integrals.

MATH 144 Finite Mathematics (3+0)3 5 Ects

Linear Systems of Equations, Elementary Operations on a Linear System, Gauss Elimination Method, Matrices, Elementary Operations on a Matrix, Multiplication of Matrices, Transpose, Rank, Elementary Matrices, Inverse of a Matrix, LU-Decomposition of a Matrix, Determinants, Properties of Determinant, Cramer's Rule, Eigenvalues and Eigenvectors, Cayley-Hamilton Theorem and Applications, Linear Combination of Vectors, Subspaces, Linear Independence and Basis, Theorem of Bases, Linear Programming, Geometrical Approach to Linear Programming Problems, The Duality Principle, The Simplex Method with Mixed Constraints, Graphs, Graph Modeling and Applications, Paths, Cycles, and Trees, Subgraphs. Graph Operations, Graph Isomorphism.

GCC 101 Career Planning and Development (2+0)0 2 Ects

The purpose of this course is to support and guide students to plan and determine their careers in accordance with their abilities, skills, competencies, personalities, and knowledge. The course aims to introduce the students to different career paths, different working environments, different worklives in various sectors-public corporations and institutions, private sector, academy, non-governmental organizations (NGOs)- and the variety of career opportunities in each different disciplines. Therefore, along with lectures, guest speakers are invited from among professionals in the private sector, public sector, academia, NGOs, as well as among entrepreneurs.

CENG 111 Concepts in Computer Engineering (3+0)3 5 Ects

An orientation course to provide counsel to the students about the Department and Computer Engineering in general. An introduction to the faculty and their activities. Visit to several Computer Centers in and outside the University. Basic computer literacy: terminology, system components and operation. Internet, HTML Coding and Java, Desktop Softwares, Windows-Unix-Dos Operating Systems, Library Usage.

Learning Outcomes:

- To be able to use main concepts of computer science.
- To be able to analyze problems and provide solutions to them.
- To be able to explain field of applications in computer engineering.
- Teaching the algorithmic thinking and design in a higher level.

CENG 112 Data Structures (3+0)3 5 Ects

Basic concepts of data, data structures and data types: arrays, strings, linear structures, sequential searching and sorting techniques, stacks, queues, pointers, linked lists. Various forms of m-way search and B-trees.

Learning Outcomes:

To be able to use and design abstract data structures.

To be able to materialize array and list data types.

To be able to design and analyze data structures and algorithms.

To be able to design and materialize abstract data structures.

To be able to materialize and use data structures and algorithms for search applications.

Prerequisite: CENG 113

CENG 113 Programming Basics (3+2)4 6 Ects

Fundamentals of computer programming: sequence, decision, repetition, syntax, compilation, debugging and maintenance, procedures, parameters, arrays, object, top-down structured design, layout and style. The emphasis is on an engineering “right-first-time” approach to solving large problems using computers. Basic concepts of algorithmics and algorithmic terminologies.

Learning Outcomes:

To be able to provide algorithmic solutions for basic problems.

To be able to use and explain main concepts of programming.

To be able to design and apply decision structures.

To be able to design and apply loop structures.

To be able to monitor and analyze computer software.

To be able to design, define and use functions.

To be able to use recursive approach for problem solving.

To be able to design, define and use class.

CENG 115 Discrete Structures (3+0)3 5 Ects

Sets, and Functions, The Fundamentals: Algorithms, the Integers, and Matrices, Methods of Proof, Mathematical Induction, Recursive Definitions, Recursive Algorithms, Program Correctness, Basics of Counting, The Pigeonhole Principle, Permutations and Combinations, Recurrence Relations, Divide-and-Conquer Relations, Inclusion-Exclusion, Relations and Their Properties, n-ary Relations, Representing Relations, Closures of Relations, Equivalence Relations, Partial Orderings, Graph Terminology, Representing Graphs and Graph Isomorphism, Connectivity, Euler and Hamiltonian Paths, Shortest Path Problems, Planar Graphs and Graph Coloring, Tree Traversal, Trees and Sorting, Spanning Trees, Minimum Spanning Trees, Boolean Functions and Their Representations, Minimization, Elements of Computability, Complexity Classes, P – NP – NP Completeness, Space Complexity, Number Conversion, Calculational Logic, Maximum and Minimum, Coding and Constructions.

Learning Outcomes:

To be able to use and compare different discrete structures.

To be able to analyze problems and determine appropriate solution paths.

To be able to show ability of abstraction.

CENG 211 Programming Fundamentals (3+0)3 5 Ects

Ideas from object-oriented programming, methods, classes, information hiding, and inheritance; fundamental algorithms, sorting and searching; user defined classes; concept of recursion, benefits and problems; exception handling; using APIs; simple graphics programming; concept of software design.

Learning Outcomes:

To be able to design object-oriented problem solutions.

To be able to provide solutions by using object-oriented programming language.

To be able to gain ability of objected-oriented programming with inheritance approach.

To be able to gain ability of objected-oriented programming with abstraction approach.

To be able to use data structures in an object-oriented manner.

Prerequisite: CENG 113

CENG 212 Concepts of Programming Languages (3+0)3 5 Ects

Syntax, semantics and pragmatics of programming languages. Data, storage and control. Binding of identifiers. Procedural abstraction. Definitions, sequences and concurrent processes. Types. Formal semantics. Study of key features of existing programming languages.

Learning Outcomes:

To able to use languages belong to different programming paradigms.

To able to easier to use a new programming language.

To be able to explain compilation and execution steps of a program.

To be able to implement high-level functions.

CENG 213 Theory of Computation (3+0)3 5 Ects

Abstract automata, especially finite state machines; push-down automata; and Turing machines. Formal languages, especially context-free languages. The relationship between automata and languages. Computability and solvability.

Learning Outcomes:

To be able to classify language definitions.

To be able to analyze problems and provide appropriate representations for them.

To be able to show abstraction ability.

To be able to identify some difficult problems in computer science.

CENG 214 Logic Design (3+2)4 6 Ects

Introduction to Computer Architecture. Number Systems. Boolean Algebra. Logic Gates and Flip Flops. Combinational and Sequential Circuit Design. Registers, Counters. Bus Transfer. RAM, ROM units. Instruction Execution and Hardwired Control.

Learning Outcomes:

To be able to analyze and design combinational circuits.

To be able to design arithmetic and logic processing units.

To be able to understand fundamentals of memory units and programmable logic circuits and use them for a circuit design.

To be able to design finite state machines and sequential logic circuits.

CENG 215 Circuits and Electronics (3+2)4 6 Ects

Fundamentals of electric circuits, including the basic concepts (e.g. voltage, current, power), basic components (e.g. resistance, inductance, capacity, MOS transistor, operational amplifier), basic laws (e.g., Ohm's law, Kirchhoff's law, equivalent resistance exchange) and methods of circuit analysis. Transient analysis, frequency response, Laplace transforms, Fourier series, introduction to electronic materials and devices, diodes, bipolar transistors and logic families, MOS technology.

Learning Outcomes:

1.To be able to analyse circuits and devise solutions to design problems.

2.To be able to design and conduct experiments, to be able to interpret the results.

3.To be able to analyse and use fundamental electronics equipment, to design electronic circuits.

4.To be able to realize logic gates based the fundamentals of digital electronics.

CENG 216 Numerical Computation (3+0)3 5 Ects

Surveys and applications of numerical techniques related to matrix inversion, systems of linear equations and optimization, finite difference expressions, interpolation and approximation, numerical differentiation and integration. The problems of speed, accuracy and applicability of the topics are examined with related algorithms. The applications of these numerical methods and subjects on computers using efficient programming techniques and with necessary programming languages.

Learning Outcomes:

To be able to explain effects of finite representation of real numbers for a given algorithm.

To be able to find numerical errors in calculations and compare numerical errors of different algorithms for the same problem.

To be able to solve numerical problems that include derivative, integral, interpolation and/or optimization.

To be able to apply recursive solutions to numerical problems.

To be able to implement linear/non-linear systems for the given problem.

To be able to apply appropriate numerical algorithm for given linear/non-linear system.

CENG 218 Analysis and Design of Algorithms (3+0)3 5 Ects

The role of algorithms in computing, Growth of functions, recurrences, probabilistic analysis and randomized algorithms, dynamic programming, greedy algorithms, advanced data structures, graph algorithms, NP-Completeness.

Learning Outcomes:

- To be able to provide solutions for problems with an algorithmic approach.
- To be able to identify algorithm design options for a given problem.
- To be able to analyse complexity of applications.

CENG 222 Probability and Statistics (3+0)3 5 Ects

Elementary probability theory, conditional probability and independence, random variables, distribution functions, joint and conditional distributions, law of large numbers, central limit theorem, parameter estimation, confidence intervals, and hypothesis testing.

Learning Outcomes:

- 1.To be able to explain and apply the concepts of probability and random variables.
- 2.To be able to describe and use common probability distributions and their properties.
- 3.To be able to employ descriptive statistics.
- 4.To be able to estimate distribution parameters.
- 5.To be able to calculate confidence intervals.
- 6.To be able to conduct hypothesis testing.
- 7.To be able to utilize computation as a tool to explore concepts in probability and statistics and to do quantitative analysis.

CENG 311 Computer Architecture (3+2)4 8 Ects

Basic computer organization and design. Instruction fetch, decode and execution. CPU organization. Hardwired and microprogrammed control organization. Arithmetic algorithms and arithmetic processor design. Input-Output organization. Memory organization, virtual memories, caches, and their management. Machine language and assembly language. Instruction formats and addressing modes. Survey of computer architectures: Von Neumann, Parallel and RISC. Pipelining and other advanced techniques for performance improvements. Introduction to parallel computing, interconnection networks, and multiprocessors.

Learning Outcomes:

- 1.To be able to design general purpose and dedicated microprocessors.
- 2.To be able to realize and test designed microprocessor.
- 3.To be able to develop programs in Assembly language.

Prerequisite: CENG 214

CENG 312 Computer Networks (3+0)3 7 Ects

Overview of computer networks: Network architecture and the ISO-OSI model. Circuit switching, packet switching. Network topology: Connectivity analysis, delay analysis and backbone analysis. Physical layer: Transmission and multiplexing, terminal handling, errors. Data link layer and link protocols. Network layer: Routing and congestion, satellite and packet radio networks, local networks. Transmission and session layer, presentation layer, application layer. Ethernet, token ring networks, protocols, discussion of some networks and their properties, network planning and management.

Learning Outcomes:

- 1.To be able to analyse systems using fundamental concepts of communication.
- 2.To be able to analyse layered network architecture and Internet protocols.
- 3.To be able to realize the designed networks and protocols.

CENG 315 Information Management (3+0)3 6 Ects

Relevance of information management in the context of computer engineering; introduction to database systems and the relational model; normal forms and their benefits; building databases, underlying methodology, database languages; issues associated with information retrieval; SQL, its use and power; information systems in the context of networks, intranets, extranets; special systems and applications; particular issues, access, security, and integrity; relevant legal and ethical issues.

Learning Outcomes:

1. To be able to design a relational database.
- 2.To be able to create a relational database.
- 3.To be able to learn relational algebra and SQL.
- 4.To be able to learn how to apply normalization to databases.
- 5.To be able to learn database concurrency methods.
- 6.To be able to learn methods to provide consistency and privacy in databases.
- 7.To be able to learn project development and presentation capability by teamwork.

CENG 316 Software Engineering (3+0)3 6 Ects

Software engineering, role of software engineers; evaluation of software and principles thereof, software lifecycle models; notions of requirements, specification, design implementation; main techniques; importance of maintenance; quality concerns at all stages of the software development process; important benefits of and good practice in software re-use; verification and validation; the use of metrics; structure of teams; human computer interface as a software engineering activity.

Learning Outcomes:

- To be able to identify requirements for a given project topic.
- To be able to find difference between functional and non-functional requirements in a project.
- To be able to make software design with an object-oriented approach.
- To be able to write project definition.
- To be able to use and apply software process model.

CENG 318 Human Computer Interaction (3+0)3 6 Ects

A review of HCI concepts and history, input devices and interaction techniques, information appliances, user interface design paradigms, 3D user interfaces, adaptive interfaces, user modeling, speech recognition and conversational interfaces, wearable computers, multimodal interfaces, and perceptual interfaces.

Learning Outcomes:

- 1.To be able to gain an understanding of human-computer interaction theory and research.
- 2.To be able to recognize the impact of system design on users' attitudes and behaviors.
- 3.To be able to describe user-centered design and evaluation processes.
- 4.To be able to employ user-centered design processes in designing and building systems.

CENG 322 Operating Systems (3+2)4 8 Ects

Classification and structure of operating systems. Storage media, memory management and dynamic storage strategies. Scheduling algorithms. I/O and interrupt structures. Protection and security. Queueing and network control models. System software: Linkers, loaders, assemblers, translators and programming environments. Case studies of existing operating systems and implementation of operating system modules.

Learning Outcomes:

To be able to learn principles of operating systems.

To be able to analyze and identify corresponding problems for the platforms including operating systems.

To able to compare different solution methods for problems of operating system and select the most appropriate one.

Restricted Elective I (3+0)3 6 Ects**(CENG 323 Project Management)**

This course is designed to introduce the engineering students to economic and management concepts. Topics will include economic concepts such as; cash flow, interest rates, rate of return, demand supply relations, product pricing, taxes, inflation, and related subjects; and management analysis such as management layers, network analysis, project management via CPM/PERT networks, optimization concepts, linear programming, and decision analysis. The course also includes use of related software.

Learning Outcomes:

- 1.To be able to recognize the personal and technical properties required for a project manager.
- 2.To be able to identify the fundamental steps of project management and risk factors.
- 3.To be able to describe the outlines of preparation, planning, application, inspection and completion phases of a project.
- 4.To be able to tell the fundamental economic concepts required for a project manager.
- 5.To be able to demonstrate computer-aided project planning and management with examples using MS Project software.

CENG 400 Summer Practice 0 4 Ects

The summer practice allows students to experience practical applications in companies. It also allows students to know general structure of the host company. With this experience students involve ongoing real-life projects.

Learning Outcomes:

- To be able to apply the learnings of the higher education in the real life problems.
- To make students conscious of their mission and responsibilities of their profession.
- To determine their working domain by allowing students to examine real life experience.
- To be capable of proposing solutions to the problems with or without a team.
- To improve their vocal and written communication capabilities and to understand the importance of foreign language knowledge.
- To present obtained knowledge with a formal report.

CENG 411 Professional Issues in Computer Engineering (3+0)3 6 Ects

Critical examination of ethical problems associated with computer engineering; discussion of these problems conducted within the framework of classical philosophical ethical theories; legal and quasi-legal (i.e., policy and regulative) issues; topics addressed include the process of ethical decision-making, privacy and confidentiality, computer crime, professional codes and responsibilities, professional practice, system security, impact of computers on society.

Learning Outcomes:

- 1.To be able to understand ethical issues in information technology.
- 2.The internalization of general ethical issues.
- 3.To be able to understand basics of privacy.
- 4.To be able to understand basics of property rights.

CENG 415 Senior Design Project & Seminar I (3+0)3 8 Ects

Writing technical reports, project management and planning, system analysis, requirement analysis, engineering ethics, data design, software design, presenting a project

Learning Outcomes:

- 1.To be able to identify problem.
- 2.To be able to analyze the problem, to define the scope, constraint, requirements, to be able to design a solution.
- 3.To be able to design a solution that is innovative, sustainable and beneficial to the environment and society.
- 4.To be able to learn and use new methods and technologies.
- 5.To be able to gain teamwork skills.
- 6.To be able to present written and oral presentation skills of the project.
- 7.To be able to describe the concepts about entrepreneurship and innovation.

CENG 416 Senior Design Project & Seminar II (3+0)3 8 Ects

Invited speakers, change management, coding documentation, coding standards, testing, reliability, security, prototyping, user manuals, group demos

Learning Outcomes:

- 1.To be able to identify problem.
- 2.To be able to analyze the problem, define the scope, constraint, requirements, and design a solution.
- 3.To be able to design a solution that is innovative, sustainable and beneficial to the environment and society.
- 4.To be able to learn and use new methods and technologies.
- 5.To be able to gain teamwork skills.
- 6.To be able to present written and oral presentation skills of the project.

Prerequisite: CENG 415

Restricted Elective II (3+0)3 6 Ects**(CENG 418 Information Security)**

Information Security is a comprehensive study of the principles and practices of computer system security including operating system security, network security, software security and web security. Topics include common attacking techniques such as virus, trojan, worms and memory exploits; the formalisms of information security such as the access control and information flow theory; the common security policies such as BLP and Biba model; the basic cryptography, RSA, cryptographic hash function, and password system; network intrusion detection; software security theory; web security; legal and ethical issues in computer security.

Learning Outcomes:

- 1.To be able to learn the common security threats in digital world.
- 2.To be able to learn the foundational theories of information security.
- 3.To be able to learn what are the basic principles and techniques when designing a secure system.

Restricted Elective II (3+0)3 6 Ects**(CENG 424 Embedded Computer Systems)**

Nature of embedded systems, particular problems, special issues; role in computer engineering; embedded microcontrollers, embedded software; real time systems, problems of timing and scheduling; testing and performance issues, reliability; low power computing, energy sources, leakage; design methodologies, software tool support for development of such systems; problems of maintenance and upgrade; networked embedded systems; FPGA design issues.

Learning Outcomes:

- To demonstrate the ability to model and design embedded systems.
- To show ability to realize and verify systems.
- To show ability to use embedded software development techniques.

TECHNICAL ELECTIVE COURSES

CENG 370 Mainframe Computing (3+0)3 6 Ects

This course introduces students to the fundamentals of mainframe computer systems, including their history and their current implementations on personal computers.

Learning Outcomes:

1. Learn the workings of the IBM mainframe operating systems
2. Be able to operate, network and administer a mainframe operating system
3. Be able to identify and write programs in Rexx and in COBOL language on the mainframe
4. Be able to present project results

CENG 381 Stochastic Processes (3+0)3 6 Ects

Probability spaces, random variables, distribution and density functions, random vectors, sequences of random variables, convergence notions, the central limit theorem, the law of large numbers, stochastic processes, stationary notions, Poisson processes, Gaussian processes, transformations of stochastic processes, ergodicity, second order random processes, representation theorems, Markov processes, homogeneous Markov models and applications.

Learning Outcomes:

1. The ability to understand and define random variables.
2. Gaining knowledge of stochastic processes and the ability to perform basic analyses.
3. The ability to understand queueing systems and to analyze simple queueing models.
4. The ability to compute and analyze certain performance criteria in queueing systems.

CENG 382 Information Theory (3+0)3 6 Ects

An introduction to Shannon's information theory and elementary binary coding schemes with and without noise. The concept of information, entropy, simple sources, Markov sources, continuous sources, information channels, average error, ambiguity, transformation, capacity, noiseless coding, Kraft-McMillan theorem, Shannon-Fano and Huffman coding schemes, error-correcting codes, linear codes, cyclic codes. Data Compression.

Learning Outcomes:

1. To do analyzing and modeling by using of fundamental concepts of information theory for signal processing and communication.
2. Analyzing, defining and doing research capability for the new requirements of information theory depend on technological evolution.
3. To have the ability for analyzing, developing and using of information theory for interdisciplinary projects.
4. To be able to measure and analyse the signal processing and communication quality and efficiency.

CENG 383 Real-Time Systems (3+0)3 6 Ects

Specification and verification techniques for real-time systems with many interacting components. formal design of real-time systems using (a) programming languages with unambiguous semantics of time – related behavior and (b) scheduling algorithms. Real-time operating systems, concepts of programming languages for real-time systems. Synchronous programming languages for reactive systems and their mathematical background. Software development for real-time systems.

Learning Outcomes:

1. To classify various kinds of real-time systems
2. To identify real-time systems and design by formal techniques.
3. To be able to create real-time kernels, and to develop programmes on operating systems
4. To demonstrate the ability to use formal methods

CENG 384 Microprocessors (3+0)3 6 Ects

Elements of microprocessors and microcomputers, software and hardware for microprocessors; microcontrollers; embedded system design with microcontrollers, memory interface, analog-digital input/output interfaces and interrupt interface of typical microprocessors/controllers; programming with assembly and high level languages; real-time working, real-time operating systems; design of single and general purpose microprocessor/controllers using FPGAs; system control, analysis of feedback control systems, controller design; data acquisition, fundamentals of digital signal processing.

Learning Outcomes:

1. Teaching 8051 programming with assembly language.
2. Explain and compare the concepts of microprocessor and microcontroller.
3. To teach the 8051 microcontroller family and its architecture.
4. Explain the software and hardware features of 8051.

CENG 385 Mathematical Logic (3+0)3 6 Ects

Propositional logic: syntax, semantics, decision procedures; first-order logic: syntax, semantics, definability, formal system, completeness, undecidability, incompleteness; second-order logic; advanced topics: many-valued logic, modal logic, temporal logic, fuzzy logic.

Learning Outcomes:

1. Resolve ambiguities in natural language sentences
2. Specifies problems in mathematical logics
3. Explains mechanisms for automated reasoning
4. Develops logical systems

CENG 386 Fuzzy Logic Systems (3+0)3 6 Ects

Fuzzy set theory, fuzzy relations, fuzzy rule base, approximate reasoning, fuzzy control, fuzzy logic system design.

Learning Outcomes:

1. Model adaptive logic using fuzzy logic
2. Simulate flexible system behaviours using fuzzy logic
3. Develop possibilistic systems
4. Evaluate reasonable system behaviour

CENG 388 Web Programming (3+0)3 6 Ects

During this course, we will be creating and maintaining a web server, creating HTML pages and learn how to program effectively in PHP. We will create a web site of your choosing as Project.

Learning Outcomes:

1. To introduce Web software development with ASP .NET
2. To describe Web software development methodologies on .NET platform
3. To provide students with the fundamental concepts of Web Services
4. To demonstrate software project development with MS Visual Studio

CENG 389 Mobile Application Development (3+0)3 6 Ects

This course covers the fundamentals of programming mobile devices, how to access and use mobile device hardware, and the interaction between mobile apps and web services. Topics include the design and implementation of user interfaces on the Android platform, cross-platform mobile application development, and programming with sensor such as the camera and the GPS.

Learning Outcomes:

1. Be able to explain the fundamental concepts of mobile device programming
2. Be able to design and implement mobile application user interfaces
3. Be able to design and implement mobile applications that utilize network services
4. Be able to analyze the user experience of mobile applications

CENG 390 Cloud Computing (3+0)3 6 Ects

This course provides a hands-on comprehensive study of Cloud concepts, the history and fundamentals of cloud computing across various cloud service models including IaaS, SaaS, PaaS, including requirements, constraints, architecture, principals, areas of implementation, advantages/disadvantages and comparison to hybrid and local architectures. PaaS topics covers a range of Cloud platforms such as Google App Engine, Amazon Web Services(AWS), Microsoft Azure and others. Topics include the design, development and implementation of cloud based mobile applications, web applications, databases and systems as well as migrating existing software applications to the cloud, working on hybrid solutions. Course offers wide range of case studies of globally recognized technology startups, products and brands which are built on cloud platforms and analyze and review them in terms of technology, operations, finance, branding and business plan aspects.

Learning Outcomes:

1. Be able to explain the fundamental concepts of cloud computing
2. Understand the advantages and disadvantages of cloud computing systems and be able to use tools on cloud platforms
3. When developing an application or system, be able to determine and decide on the appropriate platform and configuration by understanding non-functional requirements and considering aspects such as cost, performance, suitability, and security
4. Be able to design and implement mobile or web applications that run on PaaS platforms such as Amazon Web Services, Microsoft Azure, and Google App Engine
5. Be able to analyze and monitor applications built on cloud systems and optimize the system according to changing requirements
6. Be able to productize, brand, and commercialize software developed on cloud systems by establishing it as a company and launching it to the market

CENG 391 Introduction to Image Understanding (3+0)3 6 Ects

This course covers the basic image processing techniques and approaches for image content analysis.. The course content includes memory representation of images, basic image processing techniques, keypoint extraction and description, image matching and fundamentals of camera geometry.

Learning Outcomes:

1. To be able to apply image analysis methods to industrial problems
2. To be able to compare different image content analysis methods for a given problem
3. To be able to use basic image processing methods in problem solving
4. To be able to list basic image processing methods and their features

CENG398 Applied Generative AI for the Workplace (3+0)3 6 Akts

Generative AI (GenAI) is transforming the way businesses operate accelerating content creation, automating knowledge work, personalizing customer experiences, and driving product and service innovation. This module introduces students to the business potential of GenAI through a managerial lens, examining strategy, digital transformation, governance, and ethical implications. Students will gain hands-on experience with leading GenAI tools and apply them to practical business scenarios such as customer service, marketing content creation, recruitment, innovation ideation, and automated workflows. Weekly case studies and guided exercises will ground theoretical concepts in real-world practice. By the end, students will be equipped to critically assess and responsibly apply GenAI to create value in a rapidly evolving business landscape.

CENG 399 Concepts of Artificial Intelligence (3+0)3 6 Ects

This course provides an introductory and interdisciplinary overview of Artificial Intelligence with a particular focus on the foundations of machine learning. It explores the evolution, principles, and applications of intelligent systems that learn from data to make decisions and predictions. The course examines data representation, supervised and unsupervised learning approaches, and model evaluation techniques. It introduces essential algorithms for classification, regression, and clustering, as well as the basic logic of neural networks and deep learning. Students also explore applications of AI in areas such as natural language processing, computer vision, and data-driven problem solving across engineering, science, and management disciplines. Ethical and societal considerations, including bias, fairness, and data privacy, are integrated throughout.

CENG 421 Network Programming (3+0)3 6 Ects

This course covers all aspects of TCP/IP and network socket programming. Starting with a review of IP and TCP, including its services and IPv6, we will then learn about socket programming and time permitting, we will be exploring new trends in networking and programming.

Learning Outcomes:

1. To acquire knowledge on TCP/P layers and its applications
2. To program in C/C++ using TCP sockets
3. To be able to create a full-fledged web site using PHP, MySQL and HTML
4. To improve the student s ability to write programs

CENG 422 Network Design & Management (3+0)3 6 Ects

LAN/WAN analysis and design; LAN standards, internetworking, recent technologies, LAN design procedures; WAN design, network services, WAN design procedures; LAN management, SNMP (simple network management protocol); design tools, network simulators.

Learning Outcomes:

1. To have the necessary knowledge and experience to design LANs and WANs
2. To demonstrate the ability of analysing and configuring network protocols
3. To demonstrate the ability of designing a new protocol
4. To have the experience and familiarity with simulators and other tools to analyse and design networks
5. To know the fundamentals of network security

CENG 431 Building Software Systems (3+0)3 6 Ects

Concepts of open source, shareware, freeware; issues of quality, conditions of use, availability; issues of software reuse; program libraries, software components; creation of additional libraries and other components; application program interfaces; use of separate compilations; use of software libraries and other software components; problems of building large systems; assessment of software including interfaces such as metrics and measures; criteria; simple principles of interface design; multimedia issues; special problems associated with color, sound, video and multimedia; advanced issues in object-oriented programming, modularity, storage management issues, parallelism; client server computing, different kinds of servers, the role of middleware; overview of the software support needed for client services and server services; illustrations of the use of object oriented techniques applied to the building of certain commonly used software tools; applets and servlets; simple design patterns; nature of the software life cycle and its different phases; concept of process; differences across various developments and the reasons for the differences.

Learning Outcomes:

1. Know interleaved activities between specification, design, coding and testing
2. Use Object Oriented architecture components
3. Know and compare different software system development approaches
4. Analyze problems, design and implement solutions
5. Demonstrate the ability to abstract in software systems context
6. Apply software engineering methods to real world problems

CENG 432 Fundamentals of Enterprise Application Development (3+0)3 6 Ects

This course explores advanced application development techniques in a large enterprise-wide setting. Topics include agile software development, multi-tier applications, server side programming, transaction processing, web programming, application installation and deployment issues.

Learning Outcomes:

1. To be able to define and explain different types of Enterprise Applications
2. To be able to describe the development and implementation strategies of Enterprise Applications
3. To be able to demonstrate configuration, customization and programming of Enterprise Applications with examples using SAP sources

CENG 433 Scalable Software Development for Internet (3+0)3 6 Ects

Logical / physical architecture design and server components, performance measurement, advanced caching strategies, horizontal scaling with MySQL and handling peak load.

Learning Outcomes:

1. To be able implement sites that can scale up to thousands of concurrent users
2. To develop a project on Play Framework.
3. To be able implement various cache mechanisms
4. To be able to perform horizontal scaling with MySQL and handling peak load

CENG 434 Enterprise Application Integration (3+0)3 6 Ects

This course topics include types of enterprise application integration, their design and implementation issues as well as their qualities such as security, reliability and fault tolerance.

Learning Outcomes:

1. Use web service based programming techniques.
2. Know and compare different enterprise software integration approaches.
3. Analyze enterprise integration problems, design and implement solutions.
4. Demonstrate the ability to abstract in enterprise integration context.
5. Apply enterprise application integration methods to real world problems.

CENG 435 Database System Design and Implementation (3+0)3 6 Ects

This course will cover a number of advanced topics in database management systems and modern database applications. The specific topics include advanced concurrency control techniques, query processing and optimization strategies for relational database systems, advanced indexing methods, parallel and distributed database systems, next-generation data models, data mining on large databases, data on the web, and topics in data security and privacy.

Learning Outcomes:

1. To install SimpleDB database management system, customize it as required
2. To develop applications that realize all the functions of a database management system
3. To learn the approaches and methods behind the functions of a database management system
4. Finding, implementing and presenting solution to an engineering problem by means of software development in a team

Prerequisite: CENG 315

CENG 436 Distributed Information Management (3+0)3 6 Ects

This course investigates principles of distributed database systems including design and architecture, security, integrity, query processing and optimization, transaction management, concurrency control, and fault tolerance. The course blends theory with practice in that each student will use distributed database concepts to develop a JDBC application and to implement a JDBC driver onto Web-based distributed databases.

Learning Outcomes:

1. Learn design and planning principles of distributed database management systems
2. Gain the ability of creating and using distributed database
3. Learn the methods to provide consistency and security methods in distributed database management systems
4. Learn query optimization in distributed databases in detail
5. Gain the skills to prepare projects as teams

Prerequisite: CENG 315

CENG 437 Software Quality Management (3+0)3 6 Ects

This course covers the topics of software quality management, quality management paradigms (CMMI, ISO, IEEE), methods used in quality management, enhancement of quality process, management of quality cost, error, preventive error avoidance.

Learning Outcomes:

1. Ability to explain the components of Software Quality Assurance
2. Ability to apply quality components starting from the early stages of the Project
3. Ability to measure the effectiveness of Software Quality Assurance processes
4. Ability to control the impact of Software Quality
5. Assurance processes on the project budget and schedule

Prerequisite: CENG 316

CENG 441 Introduction to Parallel Programming (3+0)3 6 Ects

Introduction to the programming techniques to effectively utilize modern multicore computers. Identifying the parallelism, naming shared data, synchronizing threads, the latency and bandwidth associated with communication, analyzing & improving parallel performance, parallel programming tools, miscellaneous lab works & exercises.

Learning Outcomes:

1. Analyze the requirements for the usage of parallel programming models and efficiently implement them.
2. Comparing different parallel programming methodologies and tools, then effectively take a decision which one will be used.
3. Efficiently analyzing and conversion of sequential algorithm to parallel algorithm.
4. Analyze the efficiency of a parallelized

CENG 442 Multicore Architectures and Operating Systems (3+0)3 6 Ects

An evolutionary approach to the multicore architectures, integration of multicore architectures with operating systems, OS kernel design for multiprocessors and multithreading, OS support for threads, User level threads, Kernel level threads, An example: Solaris threads, Threads and libraries, Hardware support for multithreading in a uniprocessor and in a multiprocessor.

Learning Outcomes:

1. Analyze and implement the design steps of computer architecture by using different multicore architecture models.
2. Analyzing the components of the operating systems for multicore architectures.
3. Analyzing hardware design problems of multicore architectures.
4. Analyzing the limits of solutions and restrictions of operating systems for different multicore architecture models.

CENG 443 Heterogenous Parallel Programming (3+0)3 6 Ects

Heterogeneous GPU architecture, GPU programming models and techniques, CUDA programming.

Learning Outcomes:

1. To demonstrate the ability to design and implement programs for heterogeneous parallel programming platforms
2. To demonstrate the experience to apply the parallel programming patterns on various programming problems
3. To be able to analyze the parallel program performance and make performance optimizations

CENG 444 Parallel Programming Patterns (3+0)3 6 Ects

Parallel programming, concurrency, task parallelism, synchronization patterns.

Learning Outcomes:

1. To Be able to understand the parallel programming problems and related patterns
2. To demonstrate the experience to apply the parallel programming patterns on various programming problems
3. To be able to make a qualitative evaluation of different programming patterns and models

CENG 451 Advanced Digital System Design (3+0)3 6 Ects

Finite state machine design and analysis; high-level hardware description languages, VHDL, automated synthesis in design; digital integrated circuit design and advanced design principles; electrical properties of digital circuits, synchronous and asynchronous circuits, computer arithmetic and interfacing to external circuitry, digital system testing and design for testability; implementation of embedded computing systems in terms of Application Specific Integrated Circuits; Design for reuse.

Learning Outcomes:

1. Ability to analyze complex digital circuits
2. Ability to design complex digital circuits
3. Demonstrating the ability to use VHDL in hardware design
4. Having fundamental knowledge of digital signal processing
5. Ability to use design tools

CENG 452 Building Software for Embedded Systems (3+0)3 6 Ects

Design and implementation of software for programmable embedded systems; software tools such as compilers, schedulers, code generators, and system-level design tools; data-flow and control models of computation and software synthesis for uniprocessor and multiprocessor architectures; synchronous/reactive languages and their mathematical properties; implementation of signal processing, communication and control algorithms using variety of technologies such as digital signal processors, microcontrollers, FPGAs, ASICs and real-time operating systems; real-time kernel design; software implemented fault-tolerance techniques.

Learning Outcomes:

1. Have knowledge on the requirements of embedded software development
2. Have knowledge on various standards and tools
3. Be able to analyze and design common algorithms used in various embedded systems
4. Be able to use the knowledge of software verification, validation and test on a real project

CENG 461 Artificial Intelligence (3+0)3 6 Ects

Declarative programming; problem solving; knowledge representation; reasoning; acting logically; uncertainty; learning; communicating.

Learning Outcomes:

1. Comprehension of different artificial intelligence techniques used for simulation of human behavior
2. Interpretation of traditional artificial intelligence methods based on mathematical logic
3. Construction of intelligent behavior with respect to hybrid application of artificial intelligence methods
4. Demonstration of applications with the use result-oriented languages based and hybrid techniques

CENG 462 Soft Computing (3+0)3 6 Ects

Artificial neural networks; evolutionary computation; fuzzy systems.

Learning Outcomes:

1. Effectively use evolutionary computation in applications
2. Effectively use artificial neural networks in applications
3. Effectively use fuzzy logic in applications
4. By using these meta heuristics, provide applications with smart behaviours

CENG 463 Introduction to Machine Learning (3+0)3 6 Ects

An Introduction to the machine learning with examples in different application areas. Bayesian decision theory. Supervised learning techniques. Model selection. Dimensionality reduction. Clustering. Support vector machines. Graphical models. Introduction to neural networks. Reinforcement learning.

Learning Outcomes:

1. To be able to describe the fundamental concepts in machine learning
2. To be able to analyze the machine learning problems and identify appropriate solution techniques
3. To be able to apply proper algorithms using proper tools to solve the encountered machine learning problems
4. To be able to interpret the output of the implementations from algorithmic point of view

CENG 464 Text Mining (3+0)3 6 Ects

This course provides an opportunity to learn key components of text mining and analytics aided by the real-world datasets and the text mining toolkit written in Python. Hands-on experience in core text mining techniques including text preprocessing, sentiment analysis, and topic modeling.

Learning Outcomes:

1. Using Python and NLTK (Natural Language Toolkit) to build out your own text classifiers and solve common NLP problems
2. Performing data analysis and machine learning tasks using Python
3. Understanding the basics of computational linguistics
4. Building models for general natural language processing tasks
5. Evaluating the performance of a model with the right metrics
6. Visualizing, quantifying, and performing exploratory analysis from any text data

CENG 465 Principles of Data-Intensive Systems (3+0)3 6 Ects

The main aim of this course is to familiarize students with fundamental ideas behind a broad variety of data systems. The students will be able to compare diverse approaches, techniques, and tools for storing and processing data so that they can discuss the strengths and weaknesses of each and decide the most suitable one for their applications.

Data models and query languages; storage and retrieval; replication and partitioning in distributed data; transactions; challenges of distributed systems, consistency, and consensus in distributed systems; batch and stream processing.

Learning Outcomes:

1. To be able to define the basic terminology used in data-intensive applications
2. To be able to compare different data models and query languages
3. To be able to decide the technologies, techniques, and tools appropriate for a given task
4. To be able to design data-intensive applications

CENG 466 Big-Data and Data-driven Decision-Making (3+0)3 6 Ects

The digital revolution is generating unprecedented volumes of data across business, government, science, and society. Organizations are increasingly seeking professionals who can transform raw data into actionable insights that inform decision-making and drive innovation.

This module introduces students to the principles and practices of big data analytics, emphasizing data exploration, visualization, and interpretation in real-world contexts. Students will have the opportunity to practice data discovery, visualization and analytical techniques through case studies and hands-on exercises using some commercial (i.e. Tableau) and cloud-based solutions (i.e. AWS tools)

CENG 467 Natural Language Understanding and Generation (3+0)3 6 Ects

The main objective of the course is to provide students with a basic knowledge of natural language processing, machine learning and programming with a more advanced knowledge of existing deep learning techniques for natural language understanding and generation. The target audience is senior undergraduate students. The course covers the foundations for the deep learning for natural language processing graduate course.

Learning Outcomes:

1. Apply deep learning methods for natural language processing to industrial problems
2. Be aware of the social implications of natural language processing and know the relevant ethical terminology
3. Use different language model architectures in problem solving
4. List different natural language processing tasks and their features

CENG 471 Cryptography (3+0)3 6 Ects

Secrecy, integrity, authentication, history of the cryptography, the fundamental concepts of information theory, secrecy systems, monoalphabetical substitution, polyalphabetical substitution, transposition, block ciphers, Data Encryption Standard (DES), Advanced Encryption Standard (AES), key management, combining block ciphers, Symmetrical cryptosystem security architectures, Symmetrical cryptosystem design & verification. Factorization based (RSA), ECC based asymmetrical cryptosystems, Random number generators, prime number generators and primality testers, hashing algorithms (MD5-SHA0-SHA1-SHA2), PKI and related models, standards: IEEE P1363, Fips 186.2, – 140.2, x9.62, x9.63, PKCS#6, x509v3.

Learning Outcomes:

1. Analyze vulnerabilities, threats and which security functions are realized.
2. Selection, implementation and testing of cryptographic tools for essential security functions.
3. Objectively read the technological evolution and efficiently analyzing of new requirements for the cryptographic solutions.
4. Usage ability of the international standards for the developed cryptographic solutions.
5. Selection of the best solution and implementation ability for a cryptographic security solution depends on security requirements of domain.

CENG 472 Network Security (3+0)3 6 Ects

Link Encryption, End-to-End Encryption, Network and Internet Based Attacks, Firewalls, Email Security Issues, Web Based Security Issues, Disaster Recovery, C2 Functionality Stand-alone vs Network Operation, Hackers and Crackers, Network Crackings.

Learning Outcomes:

1. Know and compare different network security approaches.
2. Analyze network security problems, design and implement solutions.
3. Demonstrate the ability to abstract in security context.
4. Apply security engineering methods to real world problems.

CENG 473 Security of Information and Communication Technologies (3+0)3 6 Ects

Introduction to security of information and communication technologies, fundamental security functions and related cryptographic tools, network security and related problems, protection mechanisms and tool will be evaluated. Then current hot topic security problems will be analyzed for “cloud computing”, “web applications and services”, “wireless networks”, etc. and security management of information systems will be discussed. Students will have a term project for the course about an up-to-date problem of these topics, which they are interested in and will prepare a written report about it then, present their work.

Learning Outcomes:

1. Having the competence to analyze security risks related to information and communication technologies.
2. Being able to select and test the appropriate tools for solving security problems.
3. Gaining the ability to follow technological developments and identify potential security risks and threats.
4. Possessing the fundamental knowledge and methodology to carry out the security design and management of information systems.

CENG 481 Theoretical Approaches in Computer Science (3+0)3 6 Ects

Turning theoretical ideas into solution sets in computer science. Integration of mathematical approaches with general problem solving techniques and computer science applications. Topics will be from Algorithms, Complexity Theory, Game Theory, Probability Theory, Graph Theory, Automata Theory, Algebra, and Cryptography.

Learning Outcomes:

1. Analyzing capability to find new requirements and problems of current application areas of computer science
2. Defining and modelling capability of computer science hot topic research problems.
3. To have the vision and to be able to do an evaluation for the future career plans on computer science
4. To be able to apply fundamental theorems of computer science with interdisciplinary research and studies.

CENG 482 Evolutionary Computation (3+0)3 6 Ects

Evolution strategies, evolutionary programming, genetic algorithms, genetic programming, overview of selected evolutionary computation techniques.

Learning Outcomes:

1. To be able to explain evolutionary computation and its main components.
2. To be able to identify the most appropriate evolutionary computation method to a given problem.
3. To be able to apply evolutionary computation methods to optimization problems.
4. To be able to design experimental studies for evolutionary algorithms

CENG 483 Behavioural Robotics (3+0)3 6 Ects

Mechatronics; architectures; control; AI components; computer vision; mapping; planning; navigation; communication; co-operation; robot ethics; applications.

Learning Outcomes:

1. Distinguish robot types and behaviours
2. Use techniques for smart robot behaviours
3. Use techniques for collaborative robot behaviours
4. Develop robots from robotics kits

CENG 484 Data Mining (3+0)3 6 Ects

Data mining in general, data warehousing, data preparation and data mining primitives, concept description, mining association rules in large databases, classification and prediction, cluster analysis, web mining, applications in data mining.

Learning Outcomes:

1. Learn the process of knowledge discovery and data mining algorithms
2. Gain the ability of using data mining tools
3. Understand a data mining problem, design the process overflow and implement the steps
4. Document and present a Project

CENG 485 Information Technology Entrepreneurship (3+0)3 6 Ects

In addition to an introductory treatment of business fundamentals in information technology, course topics will include paradigms, strategies and methods in goal setting, team formation, intellectual property, customer projects and business management for information technologies.

Learning Outcomes:

1. To know entrepreneurship in information sciences industry.
2. To understand entrepreneur vision and thinking.
3. To be prepared to build business and products.
4. To understand the sustainable growth concept

CENG 486 Entrepreneurship for Smart Business (3+0)3 6 Ects

Components of smart business and its ecosystem. Automation of business processes. Business models for Smart Business and their implementation.

Learning Outcomes:

1. To be able to identify the needs of the real (International Business) world
2. To be able to analyze chaotic business situations and improve using Internet-based Technologies
3. To be able to identify critical components and systems that impact success in business
4. To be able to demonstrate development in data transformation and pathway to smartness
5. To be able to demonstrate ability to improve business processes with automation and smartness in smart business

CENG 487 Introduction to Computer Graphics (3+0)3 6 Ects

This course covers rendering techniques and programming interfaces for Computer Graphics. The course topics include basic mathematical concepts in Computer Graphics (two and three dimensional transformations), lighting models, methods for basic scene modeling and visibility analysis. Application of these Computer Graphics techniques on modern hardware using OpenGL is also covered.

Learning Outcomes:

1. Ability to apply computer graphics techniques using standard programming interfaces
2. Ability to derive the mathematical relationship between 3D objects and image representations
3. Ability to compare different lighting models
4. Ability to optimize rendering software using visibility data structures

CENG 488 Computer Graphics (3+0)3 6 Ects

This course covers advanced rendering techniques for Computer Graphics. The course topics include advanced lighting models, acceleration and volume rendering techniques. Acceleration of these Computer Graphics techniques on modern hardware is also covered.

Learning Outcomes:

1. Apply advanced computer graphics techniques in practice
2. Derive the mathematical equations for illumination and volume rendering techniques
3. Compare different kinds of lighting models
4. Optimize rendering software

CENG490 Blockchain Technology (3+0)3 6 Ects

The main aim of this course is to familiarize students with fundamental concepts behind blockchain and related technologies. The students will be able to develop blockchain and web3 distributed applications. Basic concepts and fundamentals of blockchain and related technologies: Decentralization philosophy; Information on the existing blockchains; Smart contracts; Consensus algorithms; Tokenization and cryptocurrency trading; NFTs and decentralized Web3 applications.

CENG 491 Supporting Area Course in Educational Curriculum (3+0)3 6 Ects

Selected topics of computer science, computer engineering, software engineering and information technologies.

CENG 499 Cooperative Education Course (0+6)3 6

This course is designed to foster collaborative partnerships between industry and academia, providing students with valuable real-world work experiences. Throughout the program, students will engage in practical, hands-on activities within professional environments, helping them connect theoretical concepts with real-life applications. The course will also guide students in exploring career options, setting professional goals, building industry networks, understanding workplace culture, and enhancing their interpersonal and communication skills essential for their future careers.