CENG 590 Seminar (0-2) Non-credit
CENG 500 M.Sc. Thesis (0-1) Non-credit
CENG 8XX Special Studies (8-0) Non-credit

**Core Courses**
- CENG 501 Introduction to Statistical Data Processing (3-0)
- CENG 502 System Modeling and Computer Simulation (3-0)
- CENG 504 Optimization Methods (3-0)
- CENG 505 Advanced Computer Networks (3-0)
- CENG 503 Computer Applications in Medicine and Biology (3-0)
- CENG 508 Digital Image Processing (3-0)
- CENG 511 Advanced Information Theory (3-0)
- CENG 512 Advanced Theory of Computation (3-0)
- CENG 513 Compiler Design and Construction (3-0)
- CENG 514 Computational Number Theory (3-0)
- CENG 515 Topics in Computer Science (3-0)
- CENG 516 Advanced Programming Languages (3-0)
- CENG 517 Classics Works in Computer Science (3-0)
- CENG 521 Advanced Operating Systems (3-0)
- CENG 522 Advanced Embedded System Design (3-0)
- CENG 523 Advanced Topics of Real Time Systems (3-0)
- CENG 524 Advanced Computer Architecture (3-0)
- CENG 531 Advanced Artificial Intelligence (3-0)
- CENG 532 Expert Systems and Knowledge Engineering (3-0)
- CENG 533 Probabilistic Reasoning (3-0)
- CENG 541 Advanced Database Management Systems (3-0)
- CENG 542 Knowledge Discovery (3-0)
- CENG 551 Advanced Software Engineering (3-0)
- CENG 552 Software Testing (3-0)
- CENG 561 Advanced Information Security (3-0)
- CENG 562 Internet Security (3-0)
- CENG 563 Database and Software Security (3-0)
- CENG 564 Information Systems Policy, Management and Organization (3-0)
- CENG 565 C4I and Information Warfare (3-0)
CENG 501 Introduction to Statistical Data Processing (3-0)3
Organization and application of computers and statistical techniques to data processing. Data handling in terms of coding, preparation, acquisition (with and without computers), screening and reduction; summarization, tabulation and analysis; random variables, statistical estimation and hypothesis testing, enumerated data analysis, linear models (regression, correlation, analysis of variance).

CENG 502 System Modeling and Computer Simulation (3-0)3
Introduction, System concept, System modeling, Monte Carlo technique, definition and selection of system input variables, generation and examination of random numbers, generation of random variables, Discrete System simulation, Discrete System Simulation Software.

CENG 504 Optimization Methods (3-0)3
Linear programming, nonlinear programming, iterative methods and dynamic programming are presented, especially as they relate to optimal control problems. Discrete and continuous optimal regulators are derived from dynamic programming approach which also leads to the Hamilton-Jakobi-Bellman Equation and the Minimum Principle. Linear quadratic regulators, linear tracking problems and output regulators are treated. Linear observer and the separation theorem are developed for controller implementation.

CENG 505 Advanced Computer Networks (3-0)3

CENG 503 Computer Applications in Medicine and Biology (3-0)3
The analysis and design of Hospital Information Systems. The mathematical, physical and Physiological basis for algorithms used in medicine, imaging and biological modeling. Topics in computer modeling of organs will be chosen from the brain, heart, nervous system, sense organs etc.

CENG 508 Digital Image Processing (3-0)3
This course covers the materials required to process and enhance photographic images, remote sensor multispatial scanner data and others. Topics include transform techniques, records and discriminate function.

CENG 511 Advanced Information Theory (3-0)3
This course will begin by explaining the methods of types. It will then address the rate distortion theory. It will also cover multiple-users channels and channels with random parameters. Finally, correlated source encoding will be provided.

CENG 512 Advanced Theory of Computation (3-0)3
This course will begin by explaining the different models of computation. It will then address the Church-Turing thesis. The course also will cover the topics of decidability and reducibility. Finally, detailed information is provided about complexity and related concepts.
CENG 513 Compiler Design and Construction (3-0)3
This course deals with the theory and practice of compiler design. It will address the topics of scanning and parsing. Semantic analysis will also be covered.

CENG 514 Computational Number Theory (3-0)3

CENG 515 Topics in Computer Science (3-0)3
Topics from advanced areas will be discussed in a seminar format. Contents may vary.

CENG 516 Advanced Programming Languages (3-0)3
Design and implement new language features, to precisely understand the rationale for existing features in modern languages, and to understand how design decisions can impact implementations.

CENG 517 Classics Works in Computer Science (3-0)3
Gödel’s undecidability theorem, computability, game theory ideas, information theory basics, graphs, networks, new directions in cryptography, the Antikythera mechanism, declarative programming, relational database model, machines and intelligence, computational complexity.

CENG 521 Advanced Operating Systems (3-0)3
Operating systems review, process synchronization, distributed system communication, synchronization in distributed systems, distributed algorithms, static and dynamic scheduling in distributed systems, group communication, fault tolerance, distributed real-time systems.

CENG 522 Advanced Embedded System Design (3-0)3
Nature of embedded systems, their role in computer engineering; special and general purpose microprocessor design, embedded microcontrollers, embedded software; real time systems, problems of timing and scheduling; testing and performance issues, reliability; design methodologies, software tool support for development of such systems; problems of maintenance and upgrade; introduction to Application Specific Integrated Circuit (ASIC) Design, VHDL.

CENG 523 Advanced Topics of Real Time Systems (3-0)3
Real-Time software design issues, real-time operating systems, real-time scheduling algorithms, formal methods in software specification, modeling and verification using timed-automata, software design, programming languages, testing, performance analysis and optimization, documentation, software re-use, fault-tolerance

CENG 524 Advanced Computer Architecture (3-0)3
Basic principles of processor design, instruction set architecture, pipelining, design of advanced memory hierarchies, multithreading, task-level and instruction-level parallelism, inter-processor communication models, multiprocessors, future trends.

CENG 531 Advanced Artificial Intelligence (3-0)3
Approaches to AI; higherorder logic; planning; expert systems; environment of AI systems; soft computing in AI systems; nonsymbolic learning; natural language processing; intelligent agent; multiagent system; semantic web; robotics.
CENG 532 Expert Systems and Knowledge Engineering (3-0)3
Introduction to the various techniques used in building an expert systems. Topics covered include: knowledge representation methods, production systems, inference procedures, uncertainty and evidence combination, expert systems architectures and control, knowledge acquisition, programming languages for expert systems, and various case studies.

CENG 533 Probabilistic Reasoning (3-0)3

CENG 541 Advanced Database Management (3-0)3
Relational theory and extensions, such as relational calculus, relational algebra, higher order normal forms; advanced DBMS concepts, such as integrity, recovery, concurrency, security, query optimisation; object-oriented databases; distributed databases, related techniques and protocols, such as data replication, data fragmentation, synchronisation, load balancing; parallel databases; deductive databases; federated databases and homogeneity/heterogeneity.

CENG 542 Knowledge Discovery (3-0)3
Knowledge discovery and data mining, 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.

CENG 551 Advanced Software Engineering (3-0)3
This course will begin by explaining the concept of software engineering. Afterwards, the software development process is described. The course will then cover software requirements, software specification, software analysis, and formal analysis. Finally, quality management, product metrics, process metrics, COTS, and software psychology are addressed.

CENG 552 Software Testing (3-0)3
Fundamentals of software testing; software test process and continuous quality improvement; Test generation using finite state models; Test adequacy assessment using black box and white box criteria; applications of model based testing.

CENG 561 Advanced Information Security (3-0)3
Concepts and applications of system and data security. Topics include risks and vulnerabilities, policy formation, controls and protection methods, database security, encryption, authentication technologies, host-based and network-based security issues, personnel and physical security issues, issues of law and privacy. Areas of particular focus include secure network design, implementation and transition issues, and techniques for responding to security breaches.

CENG 562 Internet Security (3-0)3
Internet security overview; Basic encryption techniques; TCP/IP security; Authentication protocols; Electronic mail security; Web security; Network management security; Firewalls; Intrusion detection systems, Internet security management tools.

CENG 563 Database and Software Security (3-0)3
Developments, issues, and challenges in secure databases and secure software applications. Security models, fundamentals and practices for databases and software.
CENG 564 Information Systems Policy, Management and Organization (3-0)3

CENG 565 C4I and Information Warfare (3-0)3

CENG 590 Seminar  Non-Credit (0-2)
This seminar course must be taken by all MSc students working towards their MSc thesis. The students taking the course are required to make presentations on their thesis studies and prepare progress reports and final reports.

CENG 500 MSc Thesis  Non-Credit (0-1)
Program of research leading to MSc degree, arranged between a student and the faculty member. Students register to this course in all semesters starting from the beginning of their second semester while the research program or write-up of the thesis is in progress.

CENG 8XX Special Studies  Non-Credit (8-0)
Graduate students supervised by the same faculty member study advanced topics under the guidance of their advisor.
Course Codes

Coding structure

Depart  1\textsuperscript{st}  2\textsuperscript{nd}  3\textsuperscript{rd}
ment Code

CENG  X  X  X

\textbf{1\textsuperscript{st} digit:} indicates the year

\textbf{2\textsuperscript{nd} digit:} indicates the course area

0 ⇒ General Engineering
1 ⇒ Theory
2 ⇒ Systems
3 ⇒ Artificial Intelligence
4 ⇒ Information Management
5 ⇒ Software Engineering
6 ⇒ Information Assurance
7\textsuperscript{-}8 ⇒ Reserved
9 ⇒ Non-credit courses

\textbf{3\textsuperscript{rd} digit:} indicates the number of the course from within that specific area

\textbf{Example:}
1. CENG 513 : 5\textsuperscript{th} year, Area of Theory, Modeling, 3\textsuperscript{rd} course of that area.
2. CENG 542 : 5\textsuperscript{th} year, Area of Information Management, 2\textsuperscript{nd} course of that area.